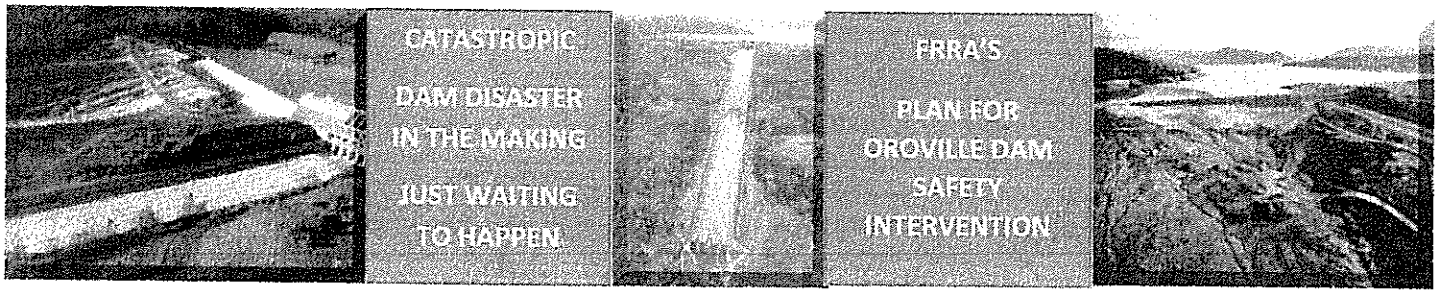
EXHIBIT 1

FEATHER RIVER RECOVERY ALLIANCE (FRRA)

An imminent and impending danger exists at the State Water Project's (SWP) Oroville Dam and Reservoir's flood control facilities that pose an unabated risk to the structural integrity and stability of those structures that levies an unreasonable level of risk to residents living within the Feather River watershed. The partial failure of the Flood Control Spillway Outlet, and the excessive erosion caused by floodwaters overtopping the Emergency Spillway, in February 2017, are indicative of the danger and risks. A recent report indicate that there are cracks in the newly constructed $1.1 billion Spillway, which Department of Water Resources (DWR) officials claims are to be expected. Conversely, a world renown forensic engineer, involved in conducting a comprehensive analysis of the cause of the Spillway failure, disputes DWR's assertion, pointing out it was the cracks in the original Spillway that caused the partial collapse of that structure. Floodwater releases from Oroville Dam are predicated on the downstream carrying capacity of the Project levees that have yet to experience the full effects of a Standard Project Flood (SPF) or a maximum Probable Rain-Storm event, within the Feather River watershed, which would be catastrophic.

Forensic Experts Find State Water Project's Oroville Dam and Gated Spillway Outlet "Managed to Failure"



"If it [Oroville Dam] failed, it would be the worst disaster in the history of the United States."

Fact Sheet is a testimony to Support FRRA's Proposed Safety Intervention to Federal Energy Regulatory Commission

OBJECTIVES-GOALS: Prepared a report for submittal to the Federal Energy Regulatory Commission (**FERC**) detailing the **FRRA**'s concerns of the unmitigated impacts due to construction, operation, and maintenance of flood control projects; e.g., Oroville Dam facilities and levee protections, within the Feather River Basin, downstream from dam.

The Summary Statement contains three (3) sections that address **FRRA**'s Objectives-Goals to identify and reconcile the intrinsic shortcomings and inherent regulatory conflicts that continue to exacerbate flood damages and loss of life attributable to government flood control projects, placing downstream residents at an unacceptable level of risk.

SECTION I: Performed a comprehensive review of flood events dating back to the 1860's to date, to assess historical efforts to reduce the threat of flooding within the Feather River water-shed. Data indicate existing flood protections, as built and managed, are detrimental to downstream property owners. Public Records reveal historical pre-1954 Sacramento Flood Control Project Levees, built along the Feather River, from Hamilton Bend, beyond the confluence of Yuba River exacerbate post-1955 downstream flood damage. Such actions appear to be in conflict with federal and state flood control rules and regulations.

SECTION II: Conducted a public records forensic account to ascertain documents that show Department of Water Resources (**DWR**) officials' actions, during flood events, have been negligent, self-serving and inconsistent with federal and state flood control rules and regulations. Such actions place the public at an unacceptable level of risk, resulting in loss of life and billions of dollars in property damages. Assessed the effectiveness of **DWR's** current flood control policies, practices and compliance with federal and state rules and regulations. The record show DWR officials monitor and police themselves!

SECTION III: Performed a forensic account of natural weather phenomenon and actions by water officials during the 1955, 1964, 1980, 1986, 1997 and 2017 flood events. Data indicate DWR's inherent conflicting roles for providing flood protection, and its contractual obligation to provide water to SWP contractors, continues to put downstream property owners at an unreasonable level of risk. Ironically, the major source of water to meet SWP contractors' needs originates in the Feather River Basin. DWR is negating its mandate to provide flood protection as a means to provide water to SWP contractors.

PURPOSE AND INTENTS OF THIS SUMMARY STATEMENT: PRELIMINARY FINDING OF FACTS

Purpose and Intent of the information contained in this Summary Statement, Fact Sheet, is to apprise decisionmakers, regulators and member of the public of FRRA's intention to petition the FERC to reopen the Alternative Licensing Process (**ALP**) pertaining to the pending license renewal for DWR's Oroville facilities License No. 2100. It is FRRA's position that the ALP process, as conducted by the DWR, was fundamentally flawed, and although there was a formal "breakdown in the ALP collaborative process" there was no functional means for redress. Also, the ALP was never used before in the FERC relicensing proceeding, which proved to be weighted in DWR's favor. Events subsequent to DWR's filing for a license renewal back in 2005 have brought new and critical issues of dam safety to light, an in the interest of public safety should warrant the reopening of the relicensing procedures for the SWP's Oroville facilities P-2100.

This DRAFT Summary Statement (**Fact-Sheet**) is based on documents and data obtained predominately from government files and other established sources of information. In order to maintain continuity of thought, there are some redundancies in ***verbatim quotations*** contained in the report.

Preliminary Finding of Facts: Government documents reveal that in the aftermath of damages sustained from the 1980, 1986, 1997 and 2017 floods, along the Feather River, downstream from the State Water Project's (SWPs) Oroville Dam and Reservoir facilities, were exacerbated by the DWR officials failure to comply with state and federal flood control rules and regulations. Subsequent to each flood event, DWR provided flood victims with assurances that corrective measures would be implemented to abate future mistakes too better manage floodwater releases and limit downstream levee and property damages. Unfortunately, by-and-large, DWR failed to follow through on its promises, the problems have become worse, and has caused a high-level of concern and anxiety of people impacted by the dam.

The data indicate that unless DWR officials, and other "responsible" agencies, institute fundamental changes in their current flood control operational and management practices, which is paramount to playing "Russian Roulette" at the SWP's Oroville facilities, and pay strict adherence to established flood control rules and regulations, failure to do so will set the stage for an unprecedented catastrophic flood disaster downstream from the Dam, which would include levee damages and failures. DWR officials' "track-record" are comparable to baseball, three-strikes and you are out; 1986, 1997 and 2017 flood events brought on by the DWR's negligence and foul play.

A Confidential DWR Report Reveals Construction of Project Levees Retain Higher Floodwater in the Feather River

In order for the reader to comprehend how and why the construction, management, and operation, of the California State Water Project (SWP) Oroville flood control facilities and levee structures that border the Feather River, present a significant and unmitigated threat to the safety, wellbeing, and sustainability, of residents in Butte, Sutter and Yuba counties and properties downstream from the dam, it is important to understand that only a portion of the historical floodwaters flows made it all the way down the mainstem of the river. A "Confidential Report" prepared by DWR officials revealed that a significant portion of floodwaters overtopped the west bank of the river, pre-1954, in the vicinity of Hamilton Bend, approximately six (6) miles downstream from the city of Oroville, flowed into the Butte and Sutter Basins. [EN] Project levees, bordering the river were completed in 1954, the 1955 disastrous flood contained higher flood flows in the channel [EN] That flood was the impetus for construction of Oroville Dam and Reservoir. The designed carrying capacity of downstream levees are the "Achilles Heel" limiting floodwater releases from the dam.

Holding Back Required Floodwater Releases to Increase Water Supply to SWP Contractors Exacerbate Levee Damage

It is important to understand that a primary cause for levee and downstream property damages are directly related to DWR officials conflicting role as a water purveyor, their overcommitted contractual obligation to meet SWP Contractors water entitlements, and their responsibilities to ensure flood protections, in accordance with state and federal flood control rules and regulations. DWR does not have the legal right to willfully "take" property[1] [2] or cause levee damages that are inconsistent with the law.[3] Especially when the DWR's actions are predicated to insure SWP contractors' water entitlements, at the expense and demise of others faced with an unreasonable level of risk. *These egregious long-term repeated failures* [at SWP Oroville Facilities] *violated the First Principle of Civil Law: "imposing Risks on people if and only if it is reasonable to assume they have consented to accept those Risks." Risk control is a central goal of Civil Law.*[4]

Does Oroville Dam's $1.1 Billion Flood Control Spillway Outlet "Fix"[5] (already cracking) and California's $17 billion Central Valley Flood Protection Plan[6] (includes the $378 million upgrade for Feather River West Levee Project) provide tangible flood protections or more false assurances, setting the stage for an unimaginable Catastrophic Flood Disaster? More importantly, will residents in the tri counties and downstream property owners continue to remain at risk and foot-the-bill to maintain the levee system along the Feather River (AKA-SWP conveyance canal)?

Synopsis of Questions and Answers (Q & A)

Q: Had the DWR ever informed residents in the greater Oroville area or downstream property owners in Butte, Sutter and Yuba counties of the severe risks of failures associated with the construction, operation and maintenance of the State Water Project's Oroville Dam and Reservoir flood control facilities?

A: To date, we have yet to find any public records that show that the DWR informed residents of the inherent risks associated with the danger of failures of the Oroville Dam flood protections facilities; however, in a recent forensic report, pertaining to the Oroville Spillway failure, it states:

These egregious long-term repeated failures violated ***the First Principle of Civil Law: "Imposing Risks on people if and only if it is reasonable to assume they have consented to accept those Risks." Risk control is a central goal of Civil Law*** *[10]* [EN]

Q: Would failure by DWR officials, to inform residents of the risks, constitute negligence?

A: ***The lack of recognition of the significance of the severe issues revealed in Appendix B, from the beginning of the construction of the spillway to present, reveals the long-term systematic failures of DWR, DSOD*** **[Division Safety of Dam],** ***and FERC to identify and rectify critical components of the Oroville Dam Gated Spillway to the required level of the Operating Standard of Care: thus, "Negligent."*** [EN9]

Q: Is DWR required by the Federal Energy Regulatory Agency to have an adopted "Emergency Action Plan" (EAP) for the SWP's Oroville Dam and Reservoir to respond to an event such as the 7 February 2017 partial collapse of the Flood Control Spillway Outlet?

A: Yes! DWR submitted an Emergency Action Plan to the Federal Energy Regulatory Commission, which was approved in 2015.

Q: Is the EAP readily available for public review?

A: No! While public officials flounder, assuring residents there was no need for concern, then, abruptly ordered the evacuation of 188,000 people, reporters failed to ask the quintessential question, where was the DWR's **"Emergency Action Plan" (EAP)** for the Oroville Dam facilities required by the FERC that includes the Flood Control Spillway Outlet and Emergency Spillway.

Early on, PorgansIAssociates (PIA) made contact with FERC personnel to obtain a copy of the latest EAP filed by the DWR for the Oroville facilities. FERC's Office of External Affairs stated, it is a Freedom of Information Act (FOIA) request, which could take 30 to 60 days or more to receive a response. Furthermore, FERC's attorneys would review the nature of the FOIA request and discuss the release of the EAP with the DWR's attorneys to get their input before considering releasing the Plan. If the Plan was released, PIA would have to sign a Non-Disclosure form stating the EAP is not to be shared with anyone. When questioned about the absence of the EAP, **DWR officials stated release of the EAP would be a breach of National Security! [EN]**

Q: Has government efforts to effectively reconcile the threat of historical flood events within the upper and lower regions of the Feather River watershed been successful ?

A: No! According to government records, although hundreds of millions-of-dollars of taxpayers' money have been expended for levee construction and for

flood protection assured by the operation of the SWP's Oroville Dam and Reservoir flood control facilities, reoccurring flood disaster downstream along the Feather River accelerated; causing billions-of-dollars in property and levee damages.[7]

Q: Did the DWR or SWP contractors pay for the Oroville Dam and Reservoir flood control facilities?

A: No! *A monetary contribution by the Federal Government toward the construction cost of Oroville Dam and Reservoir in the interest of flood control was authorized by the Flood Control Act of 1958 (Public Law 85-500, 3 July 1958, 85th Congress, 2nd Session). Based on the flood control benefits to be derived, 22 percent of the construction cost of the dam and reservoir, exclusive of power and recreational facilities, was allocated to flood control with a total sum not to exceed $85million. The cost allocation was approved by the President on 10 January 1962.[8]*

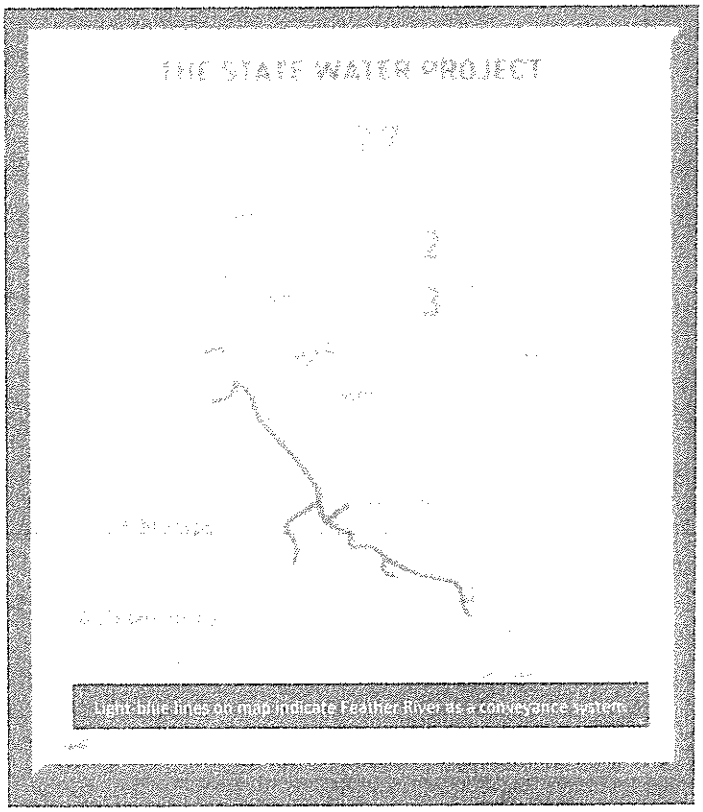
Q: Does DWR or the SWP contractors pay for the construction, maintenance and operation of the Sacramento River Flood Control Project levees, constructed along the banks of the Feather River?

A: No! Although it is a known fact that DWR uses the Feather River as a channel to convey water from Oroville's SWP facilities, neither it nor SWP contractors pay for the cost of maintaining the project levees. For example, the Feather River West Levee Improvement Project cost $378 million. Money to fund levee construction, maintenance, and improvements is paid for by downstream landowners (property assessments), issuance of General Obligation Bonds, repaid by taxpayers from the State's General Fund), and other public sources.

Currently, the Sutter-Butte Flood Control Agency is attempting to impose an assessment on downstream property owners for the annual operation, maintenance, and repair of these levees. The floods of 1905, 1907, 1937, and 1955, experienced along the Feather River, served as the catalyst for construction of Project levees, completed on the west bank of the river in the early 1950's, that cost millions of dollars.[9]

Q Did government conduct a cost-benefit analysis to justified construction and operation of Project levees and Oroville Dam and Reservoir flood control projects on the basis that they would reduce flood damages and loss of life?

A **Yes! However, that raises questions as to how effective construction of Project levees, along the Feather River, and the flood control facilities at the SWP's Oroville Dam and Reservoir have been?[10]** [EN]



Light billboards on map indicate Feather River as a conveyance system.

Q: Should State Water Project Contractors pay to maintain Feather River levees?

A: SWP contractors are beneficiaries of water conveyed via the Feather River channel, and as such, it would only be reasonable for them to bare a portion of maintaining and improving levees.

Q: What was government's original intent to obstruct and confine the natural flood flows, the magnitude of which were rarely contained in the Feather River channel, pre-1955, upon completion of levees?

A: According to public records government's actions to obstruct natural floodwater overflow from the Feather River was designed and constructed to protect Project levees on the Sacramento River and the Sutter Bypass from being damaged.[EN]

"Since 1950, 19 flood events in the basin have required extensive flood fighting, and the flood of 1955 resulted in 38 deaths", according to the USACE. [EN] Be mindful those figures do not include the February 2017 partial collapse of the SWP Oroville Dam Flood Control Spillway Outlet, which cost $1.1 billion to repair, which does not include interest payments. Furthermore, two (2) Independent Forensic Reports revealed that the near catastrophic disaster was the result of the DWR's failure to properly design, construct and maintain the Flood Control Spillway Outlet.[11] [EN]

Government reports estimated that those facilities would reduce flood damages. Conversely, the data indicates that from 1980 through 2017 flood damages attributed to the operation and management of these facilities have been in the billions of dollars! Additional research is required to ascertain the benefits and cost.

Q: Was government's action to confine historical naturally occurring floodwaters that once overflowed the banks along the Feather River Channel, downstream from the City of Oroville, to protect existing Sacramento Flood Control Project levees on the Sacramento River from being damaged, consistent with federal and state flood control regulations?

A: Government's decision to construct levees and confined floodwaters within the channel knowingly exacerbate flood damages along the Feather River, which appears to be inconsistent with the purpose and intent of established flood control rules and regulations and case law.[12] [EN]

Q: What is the source of funding to pay for DWR's negligence for failure to properly maintain the SWP Oroville Dam Flood Control Spillway?

A: It was initially assumed that the $1.1 billion would be paid for through the Federal Emergency Management Agency (FEMA). However, according to a statement issued by President Trump, FEMA would only fund spillway repairs directly related to damages resulting from an emergency and no funding for damages attributable to negligence, mismanagement or lack of maintenance.[13] [EN] Recently, FEMA denied DWR's request for more than $300 million for spillway repairs on the grounds it was not the result of an emergency. A FRRA member wrote to FEMA supporting its decision. Funding provided by FEMA is paid for by U.S. taxpayers. [EN] (Refer to SECTION I.)

Q: Is DWR or the SWP contractors held financially responsible for flood damages along the Feather and Yuba Rivers for failure to comply with federal and state flood control rules and regulations?

A: No! Flood victims' that sustained damages resulting from DWR's failure to comply with federal and state rules and regulations can file a claim for damages with the California Department of General Services, which is generally denied.[EN] However, this procedure enables the injured party(s) to file a lawsuit against DWR.[14] [EN]

Q: Have flood victims successfully prevailed in litigation for damages attributable to DWR's failure to comply with federal and state flood control rules and regulations?

A: Yes! Litigants were successful in obtaining compensation for damages from the 1980, 1986, and 1997 flood damages attributable to DWR's failure to comply with federal and state flood control rules and regulations. Two cases of note are the 1986 Paterno lawsuit [EN] and the Mann 1997 lawsuit. [EN] The appellate court ruled in the plaintiffs favor in the 1986 Paterno case and awarded plaintiffs $464 million dollars for damages. [EN] DWR was represented by the state's attorney general settled the 1997 Mann lawsuit for $45 million. [EN] The total amount paid to flood victims, for the two flood events, was $504 million; however, that does not include interest payments!

Q: Does DWR pay for the cost of the flood damages attributable to its mistakes and for loss of life?

A: No! The money to pay for the damages caused by DWR come from the State's General Fund, which is collected from Californians taxes. [EN]

In all, California taxpayers will pay $464 million to nearly 3,000 people and their heirs, as well as businesses and their insurers, affected by the collapse of earthen mound along the Yuba River [1986 flood]. *The total is more than the annual budget of the state Department of Parks and Recreation, the state Department of Fish and Game or the state Energy Commission.*[15] [EN]*

According to DWR, *"**The total settlement was $464 million which was identified as a General Fund obligation.** No bond funding was used. The State entered into a 10-year loan agreement with Merrill Lynch. Merrill Lynch paid upfront cash to plaintiffs. The State, via DWR, has been paying Merrill Lynch in 2 semi-annual payments each year with interest. **DWR builds General Fund monies into our budget each fiscal year, so we more or less serve as the pass-through entity.**"*[16] [Emphasis added][EN]

DWR was represented by the state's attorney general, and government settled the 1997 Mann lawsuit using money from the state's deficit-ridden General Fund. *Legislation that provides $45 million to settle the 1997 Yuba County flood*

case was signed back in May 2005 by former Gov. Arnold Schwarzenegger.

Mann's case was helped by a state appeals court ruling in the 1986 Yuba County flood case that held the state liable for damages. The state is settling that case for $464 million." [17]

Fiscal Issue—How Much Would It Cost? *As with any bond measure, the price of deferring payment is the increased cost of interest payments. According to our* [Legislative Analyst's Office] *estimates, the total cost to the state of paying a $464 million settlement through a judgment bond would be approximately $915 million, assuming a 30-year term of the bond. Accordingly, paying the state's settlement obligation through borrowing nearly doubles the total cost to the state over the long term.*[18] [EN]

Q: Will California's $17 Billion Flood Plan[19] (Levee Upgrades) or the $1.1 Billion Flood Control "Fix"[20] Provide Real Protections or More False Assurances Setting the Stage for a major Catastrophic Disaster?

A: "If it [Oroville Dam] failed, it would be the worst disaster in the history of the United States."[21] [EN]

The 2012 $17 billion Central Valley Flood Protection Plan did include three major components that would have provided "real protections and improvements"; however, they were gutted-out of the Plan. (**1**) Reoperation of Oroville Dam to provide additional flood storage space during flood season, (**2**) Widening Cherokee Canal to allow a portion of the floodwater releases from Oroville Reservoir to be diverted, and (**3**) Dredging sections of the Feather River channel.

The spillway was rebuilt and completed last November as part of a $1 billion construction job. It's safe and ready for service, said Erin Mellon, a spokeswoman for the state Department of Water Resources.

"The spillway has been reconstructed using the best engineering practices of the day," Mellon said Tuesday. "We are confident in its reconstruction."

"We've done so under the oversight of state and federal regulators, outside experts and scientists," she added. "It's been reconstructed to handle very large flows, which we certainly don't anticipate ever putting down the spillway."[22] [EN] [Emphasis added]

In March 2019, FEMA notified DWR that it does not consider some spillway reconstruction work to be eligible for reimbursement based on information DWR had previously submitted at the end of 2018. DWR has appealed this initial reimbursement determination and provided further information and updated cost estimates to support the department's appeal. To date, FEMA has approved reimbursement of $337.4 million. For a copy of the appeal, contact DWR at erin.mellon@water.ca.gov.[23] [EN]

THIS JUST IN ... CalOES Submits Oroville Spillways Reimbursement Appeal on Behalf of DWR.[24]

Small cracks have appeared in a new concrete spillway at Oroville Dam, a development state officials say was expected but an engineering expert says could lead to serious safety issues. [Emphasis added]

In a previously undisclosed October letter, federal regulators asked Department of Water Resources officials to explain the hairline cracks on the dam's new massive concrete flood-control chute, *KQED radio of San Francisco reported Tuesday.* [Emphasis added]

The Federal Energy Regulatory Commission also asked water officials what, if any, steps might be required to address the issue. [Emphasis added]

In February, authorities ordered nearly 200,000 people downstream of the dam to evacuate when both spillways suddenly began crumbling. The feared uncontrolled releases of water over the dam did not occur, and authorities allowed residents to return to their homes within days.[25] [EN]

In their response to federal regulators, California water officials said in November that the state's efforts to build a more durable spillway caused the cracks, which were anticipated. [Emphasis added]

"The hairline cracks are a result of some of the design elements included to restrain the slabs and produce a robust and durable structure," *the letter read, adding that the* ***cracking "was anticipated and is not expected to affect the integrity of the slabs."*** [Emphasis added]

The evidence for and reasoning behind DWR's statements about the cause of the cracking is not available for independent assessment, the station reported.[26] [EN] [Emphasis added]

University of California civil engineering professor Robert Bea, a veteran analyst of structure failures, said cracking in high-strength reinforced concrete structures is never expected.

The cracking "develops paths for water to reach the steel elements embedded in the concrete and accelerate corrosion," Bea wrote in an email. "Such corrosion was

responsible for the degradation and ultimate failure of the steel reinforcing in parts of the original gated spillway."[27] [EN] [Emphasis added]

Q: Have DWR officials operated the Oroville flood control facilities in accordance with federally mandated flood control rules and regulations during the 1980, 1986, 1997 and 2017 flood events?

A: **No!** According to government documents, DWR officials failed to operate Oroville flood control facilities and downstream levee structures in compliance with state and federally mandated flood control rules and regulations during the 1980, 1986, 1997 and 2017 flood events. Documents to support these assertions were obtained via Freedom of Information act (FIOA) and California Public Records Act request.[28] [EN]

Q: How accurate is DWR self-reporting and compliance record for the operation and maintenance of the SWP's Oroville flood control facilities?

A: Public records and depositions of DWR officials, by Daniel V. Blackstock, Esq., Law Offices of Leonard & Lyde, revealed that numbers detailing g inflow and outflow, listed in the reservoir operation logs and monthly reports, pertaining to flood control operations, were altered "whited-out" and changed. When questioned, under oath, about the obvious discrepancies, the responsible DRW officials could not explain why such changes were made. The accuracy of this data is critical as it provides documentation to confirm that DWR is operating the flood control facilities in accordance with state and federal rules and regulations.[29] [EN]

Q: What government entity is responsible for ensuring compliance with flood control rules and regulations promulgated by the U.S. Army Corps of Engineers (Corps) for operation of Oroville Dam and Reservoir?

A: Once the Corps establish the flood control rules and regulations for the operation of Oroville Dam and Reservoir flood control it is the responsibility of DWR to ensure compliance; essentially, **DWR officials are monitoring and policing themselves!**[30] [EN] [Emphasis added]

Q: Does the Department of Water Resources Own the Water Stored at Oroville Reservoir?

A: No! The DWR does not own that water; it has a permit to use the water that it obtained from the State Water Resources Control Board. Water is classified as a Public Trust resource, which is owned by the people.[31]

Q: How much do SWP contractors actually pay for the water it receives from the Feather River?

A: **Nothing!** The SWP contractors do pay other costs associated with the water they receive, but there is no charge for the water itself; **it is free!**[32] [EN]

Q: Does DWR Own the State Water Project?

A: The answer to this question is currently being pursued, because DWR's legal counsel claims that the Department owns the SWP;[33] however, the SWP is a public asset, which belongs to the people of California. **[EN] The enabling legislation that authorized and approved the SWP makes no reference to** DWR ownership. The DWR has been given the authority to manage, maintain, and operate the SWP.[34] [EN]

Q: Has DWR managed, maintained, and operated the SWP's Oroville Dam and Reservoir flood control facilities in accordance with state and federal flood control rules and regulations?

A: **No!** According to two independent Forensic Reports that assessed the cause of the partial failure of the Flood Control Spillway Outlet, it was managed to fail.[35]

Due to the multi-decade 'Loss of Core competencies' the management of DWR and DSOS (Division Safety of Dams) failed to provide adequate Management (planning, organizing, leading, controlling), Engineering, Operation, and Maintenance personnel 'skills, knowledge and performance capabilities and other important 'resources' required to effectively prevent and mitigate failures of the Gated Spillway. The Gated Spillway was 'managed to failure' by DWR and DSOD.[36] [EN] [Emphasis added]

Q: What is the primary purpose of the Oroville Dam flood control protections?

A: ***The primary objectives of flood control operations are (1) to minimize flood damages downstream, and (2) to avoid causing damages, insofar as practicable, that would not have occurred under conditions without the project.*** *The release schedule shown on Chart A-1 will provide protection for agricultural development with the floodway from frequently occurring floods, without scarifying reservoir design flood (SPF) protection for lands outside the floodway.*[37]

Q: What are DWR's responsibilities?

A: *DWR is responsible for managing and protecting California's water resources and works with others to benefit the State's people and to protect, restore, and enhance the natural and human environments. DWR operates and maintains the State Water Project, oversees dam safety, provides flood protection, helps in emergency response, assists regional and local water agencies, promotes water conservation and safety, and plans integrated watershed management – in all to advance water resources sustainability.*[38] [EN]

Q: Has DWR managed and operated the SWP's Oroville Dam and Reservoir flood control facilities in accordance with state and federal flood control rules and regulations during the 1980, 1986, 1997, and 2017 flood events.

A: **No!** In each of those flood events, public documents confirm that DWR officials failed to operate the flood control facilities in accordance with both state and federal rules and regulations.[EN] DWR officials' negligence and failure to adhere to flood control rules and regulations resulted in extensive damage to the Oroville Dam Flood Control Spillway Outlet and downstream flood damages and loss of lives.[39]

Q: Has the Oroville Dam and Reservoir experienced a "Standard Project Flood" (SPF) event as defined in the federal Flood Control Manual?

A: **No!** Although the Oroville Dam experienced several major flood events, it has not experienced a SPF. The criteria for such an event, occurs when 440,000 cubic feet per second flows into the reservoir, with a 72-hour volume of 1.5 million acre-feet[40] of water.[41] In Jan. 1997, DWR issued an evacuation order for Oroville anticipating inflow of 440,000 c.f.s.[42]

PROBABLE MAXIMUM RAIN FLOOD: ***A probable maximum rain flood on the Feather River above Oroville Dam, developed for spillway design purposes, has a peak flow of 720,000 c.f.s. and a 72-hour runoff value of 2,510,000 acre-feet,*** *and results from a 72-hour storm depositing 21.1 inches of precipitation on the drainage area above Oroville Reservoir.*[43] **[EN]**

Q: Has the SPF or the Maximum Rain Flood Occurred on the Feather River since construction of the Project Levee System or Oroville Dam?

A: No! The maximum inflow, into the Oroville Reservoir was 301,002 acre-feet of water with a 72-hour volume of 1.2 million acre-feet, which occurred in January 1997.[44] [EN]

Q: Has DWR released floodwaters from Oroville Dam in excess of what is required in the Flood Control Manual not to exceed downstream channel capacities?

A: Yes! According to official records, certain flood control facilities were not operated in compliance with state and federal flood control rules and regulations. For example, DWR officials apparently failed to operate the SWP Oroville flood control facilities in accordance with the floodwater releases required in the Oroville Dam Flood Control Manual; flood water releases were at rates higher than called for in the Channel Design Flow capacity permitted in the Manual.[45]

Annually inspecting channel conditions to determine if any deterioration in flow capacity has occurred that could inhibit release of water corresponding to flows of 150,000 c.f.s. below Oroville Dam or 180,000 c.f.s. in the Feather River above Yuba River, 300,000 c.f.s below Yuba River, and 320,000 c.f.s. below Bear River.[46]

During the 1997 flood floodwater flows in the Feather River below the confluence of the Yuba River were in excess of 350,000 cfs. [47]

The Channel Design Flow capacity for the Yuba River just above its confluence with the Feather River is 120,000 c.f.s. During the 1997 flood the flow in the Yuba River was 173,600 c.f.s.; this is in the area were the levee failed.[48]

*"**Releases from Oroville Dam are not to be increased more than 10,000 c.f.s. or decreased more than 5,000 c.f.s. in any 2-hours.**"*[49] [EN]

DWR's records also reveal that on a number of occasions, during the January 1997 flood event, it increased flood water releases in 20,000 c.f.s. increments within a 2-hour period.[50] [EN] In addition, under the condition that prevailed during the 1997 flood event, DWR officials exceeded the maximum allowable floodwater release of 150,000 c.f.s. to163,000 c.f.s. The 150,000 c.f.s. is a level of floodwater release permitted in flood events with conditions consistent with the criteria referred to as a "Standard Project Flood."[51] [EN]

EXHIBIT 2

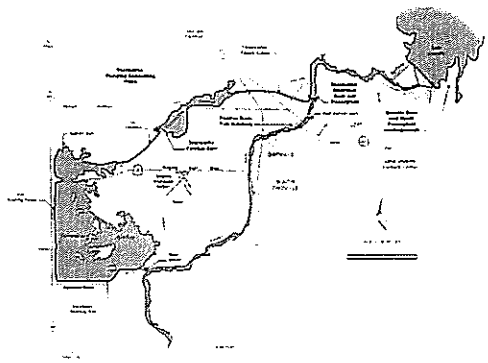
Oroville Dam Complex Sagas

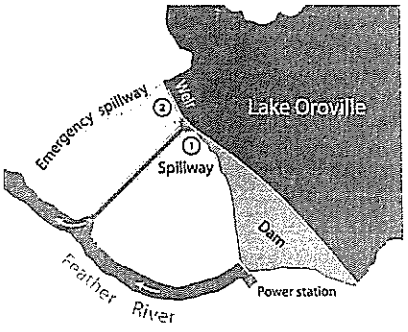
Miscues, Regulator Mistakes,
and Reflections on Where We've Been
and the Mysteries of Where We Are Going?

California Rivers Day Legislative Briefing
State Capitol, May 3, 2017

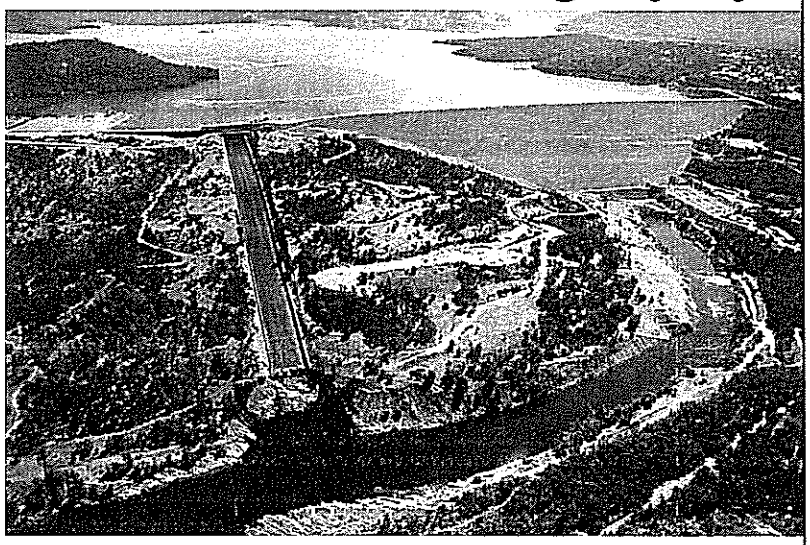
Presented by Ron Stork, Friends of the River

Some Geography





More Geography



Oroville Dam Factlets

3.5 million acre-feet "keystone of the State Water Project currently undergoing relicensing. 750,000 acre-feet flood space reservation, 150,000 acre-feet surcharge reservation

17,000 cfs powerhouse; 5,000 cfs river outlets

296,000 cfs main service spillway (at spillway design flood)

350,000 cfs auxiliary/emergency spillway (as above)

Operated according to 1970 ACE reservoir regulation manual ("interim" operations [actual conditions] are limited to one paragraph and one page). Objective release, 150,000 cfs

1970

1997 Floods

Record Oroville Dam inflow (300,000 cfs) Record outflow (160,000 cfs) (hourly data)

City of Oroville told to stand by to evacuate in twelve hours if DWR has to begin pass-through (300,000 cfs) operation. Downstream communities evacuated.

However, reservoir storage peaked 200,000 acre-feet (13.8 ft), well below emergency/auxiliary spillway crest.

Feather River left-bank levee breaks downstream of Marysville (Country Club Lane Break).

Response

Yuba Feather WorkGroup forms (funded by CALFED) by 2000

Focus: improving floodwater management in Feather River Basin

Most active participants: Yuba County Water Agency, Sutter County, Levee District 1, South Yuba River Citizens League, Friends of the River, Sierra Club, DWR.

Deficiencies with Oroville Dam's emergency/auxiliary spillway are frequent part of discussions.

Concern is that general havoc (hillside erosion) will prevent operators from undertaking Corps-manual surcharge operations to contain combined spillway outflows within downstream levees when required. Further, use could result in loss of crest control. That would be bad. Solution: a real spillway.

Lack of Response and Counter Response

Written analysis of spillway deficiencies made available to DWR date back to August 23, 2001.

Yuba County Water Agency publishes August 2002 Technical Memorandum describing, in part, havoc associated with use of emergency spillway.

Detailed discussions with DWR FERC-licensing staff take place in 2002 through 2004. DWR takes position the spillway matter is not appropriate for a relicensing proceeding. Workgroup members believe otherwise.

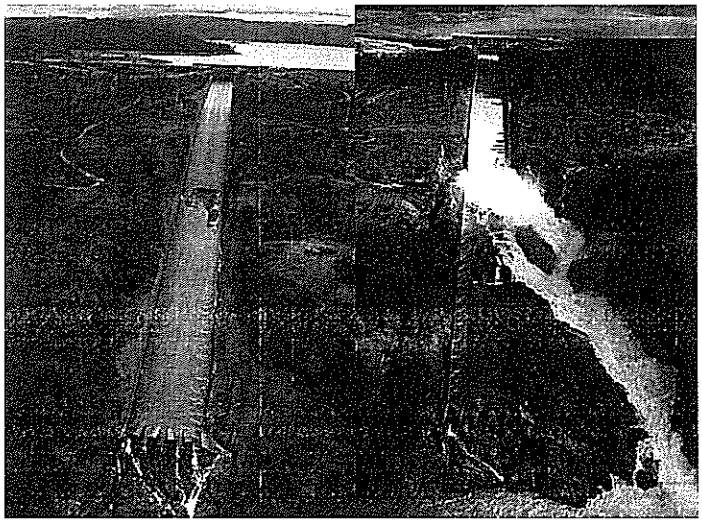
In January of 2004, WorkGroup informs DWR that it recognizes stalemate and informs DWR that stakeholders will bring the matter to FERC licensing proceeding. FOR files comments in June 2004 with FERC objecting to DWR's position.

In October 2005, FOR/SYRCL/Sierra Club Intervene citing YCWA technical memorandum plus concern that use could result in loss of crest control. Sutter County, Yuba City, and Levee District 1 file for intervention later also raising these issues. FOR et al. argue operational requirements of dam are not supported by the physical structures (i.e. emergency spillway).

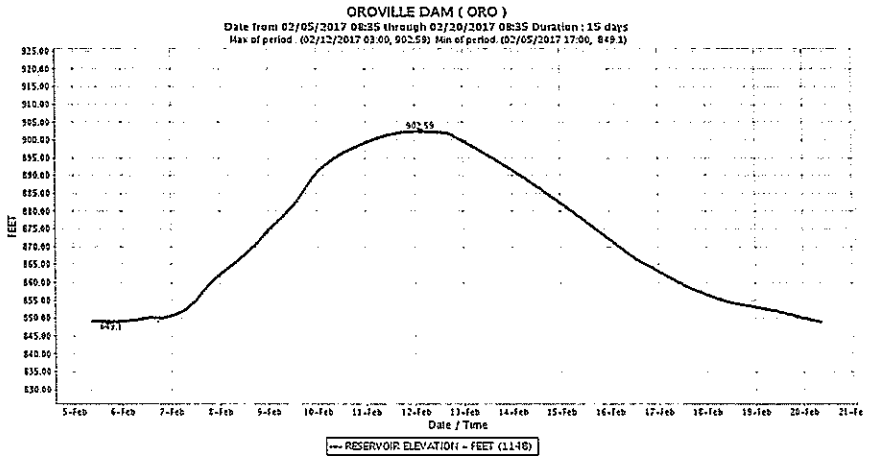
Hiding the Ball or Self-Decption?

- FERC Licensing in DC asks FERC Dam Safety in San Francisco what they think of Intervention issues (May 26, 2006)
- DWR assures FERC Dam Safety that emergency spillway can safely pass spillway design flow (350,000 cfs). Speaks of only 1 to 4 feet of erodible soil on hillside.
- Bypassing the operational issues of problems with use of emergency/auxiliary spillway, FERC SF Dam Safety assures FERC licensing staff the emergency/auxiliary spillway can safely pass spillway design flood. (July 27, 2006)
- Conclusion document from FERC SF Dam Safety is only document made available. Any work (if any) supporting the conclusions is secret (CEII).
- FERC licensing accepts SF FERC Dam Safety conclusions and fails to propose any spillway improvements at Oroville Dam but does accept our description of DWR's ACE operational requirements. (2006)
- SWRCB issues water quality certification (~~2008~~ 2010)

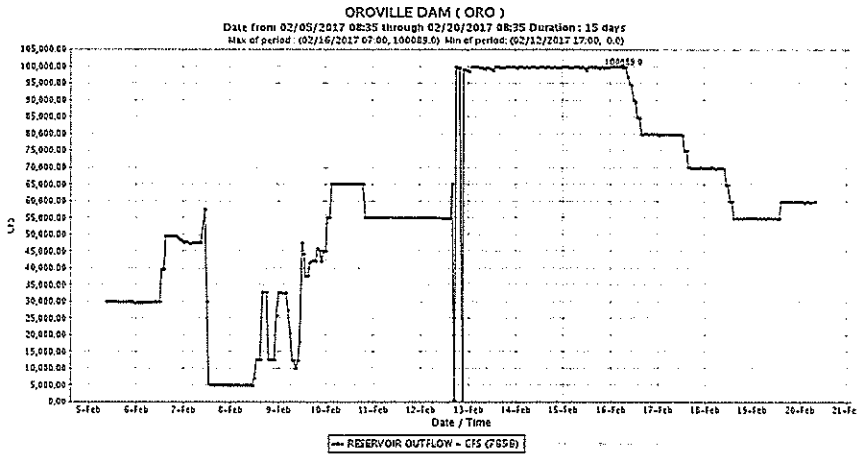
2017 Spillway Incident

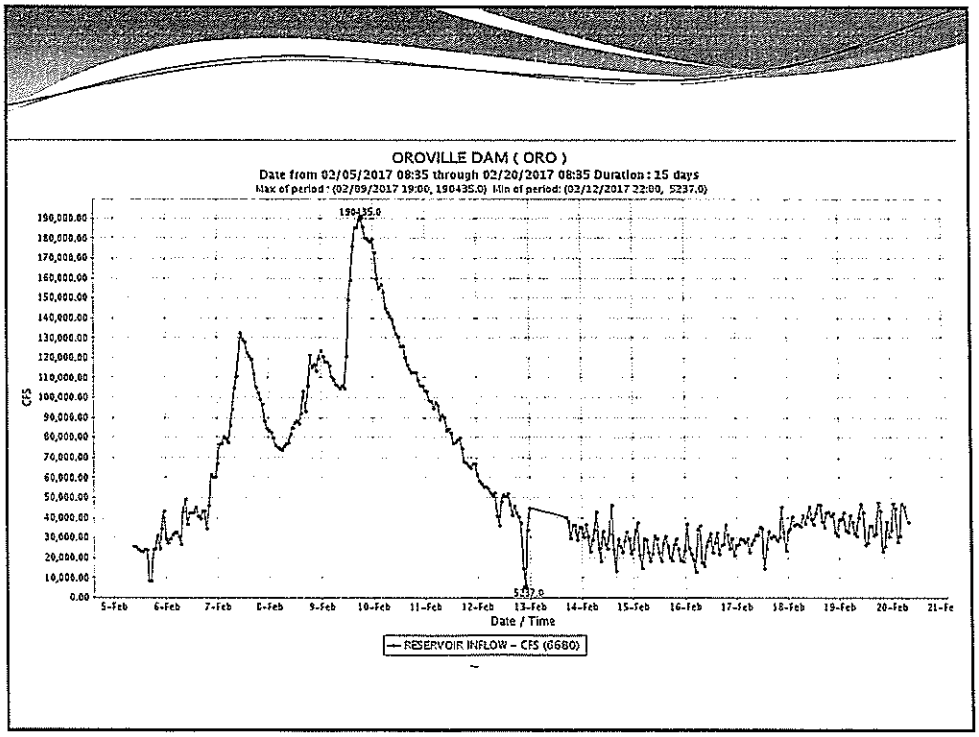


Oroville Incident Reservoir Levels

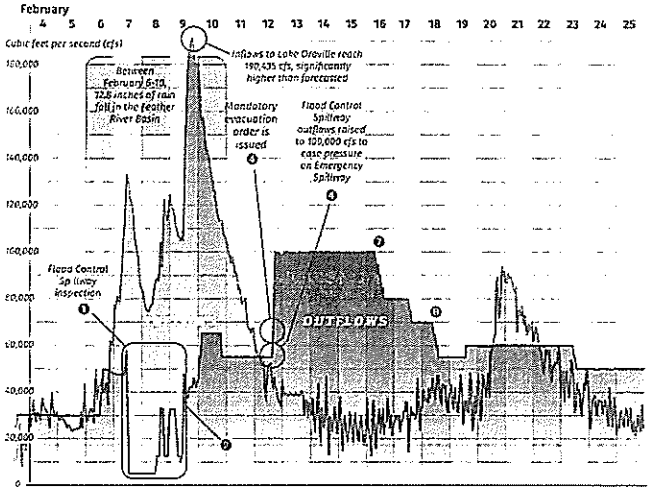


Oroville Incident Outflows

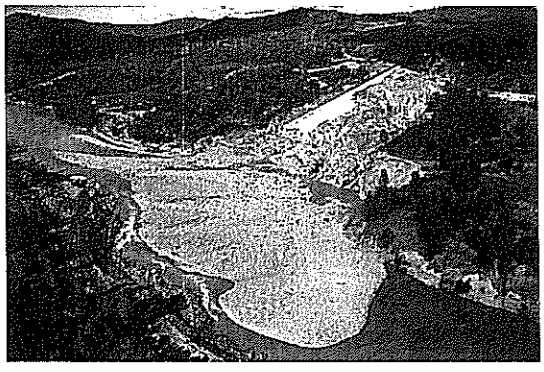


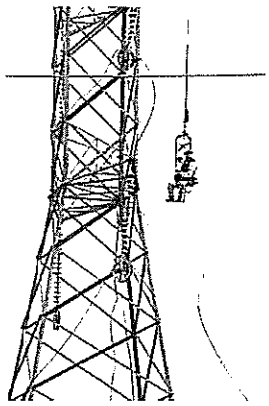


Oroville Incident Flow Synthesis



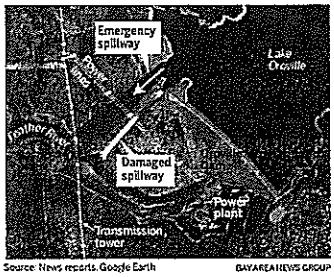
Havoc





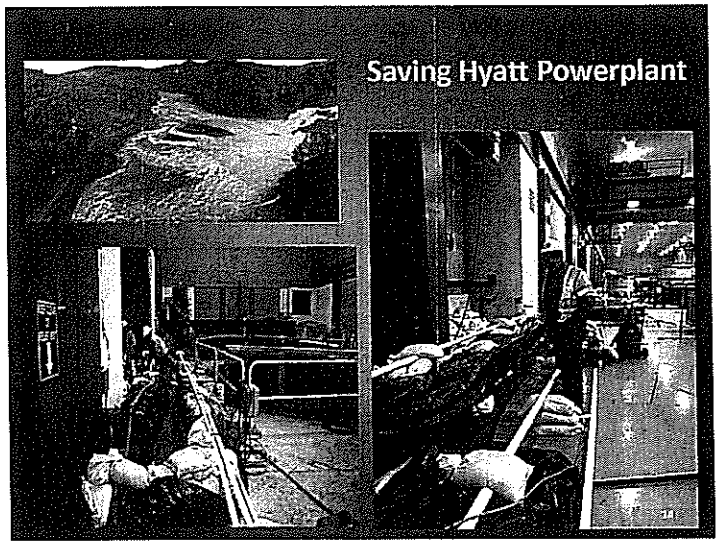
More Havoc

USING THE EMERGENCY SPILLWAY
Because of the damaged concrete spillway at Oroville Dam, excess water may be released via an emergency spillway. This spillway is a last resort, because water rushing down its unprotected hillside would send rocks, trees and debris into the Feather River.



Source: News reports, Google Earth BAYAREANEWS GROUP

More Havoc

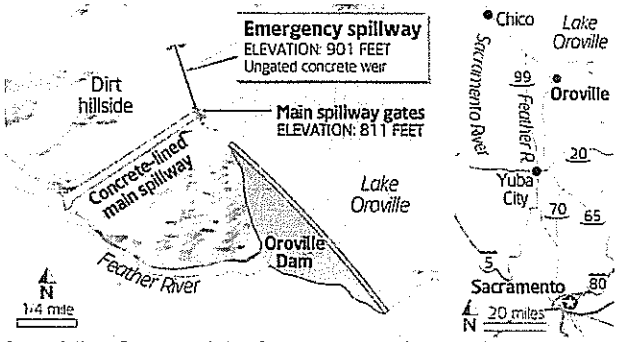


Using the Auxiliary Spillway would be a bad thing, perhaps very bad

Actual fear was loss of hilltop crest control and catastrophic release of top of reservoir. The threat to the dam structure itself would require considerable hillside failure, probably only a remote possibility

Spillway concerns

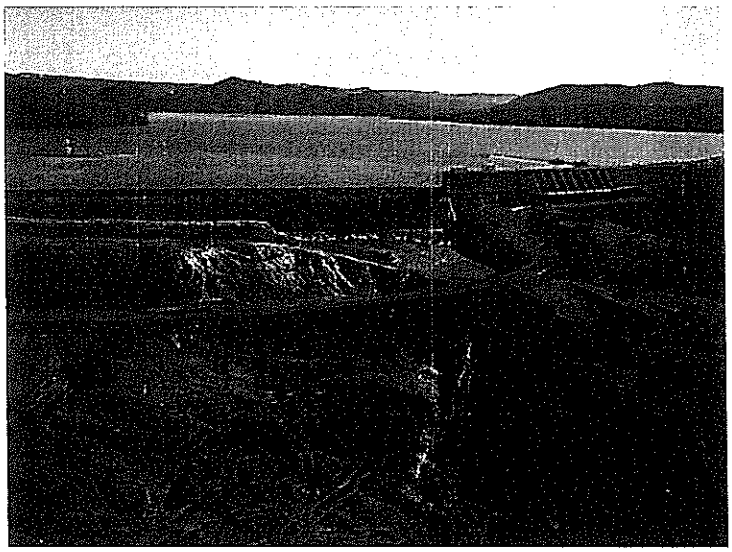
The Oroville Dam's emergency spillway – which has never been used – empties onto a dirt hillside rather than a concrete pad. Some local groups fear the spillway's use would erode the hillside, possibly threatening the dam itself.



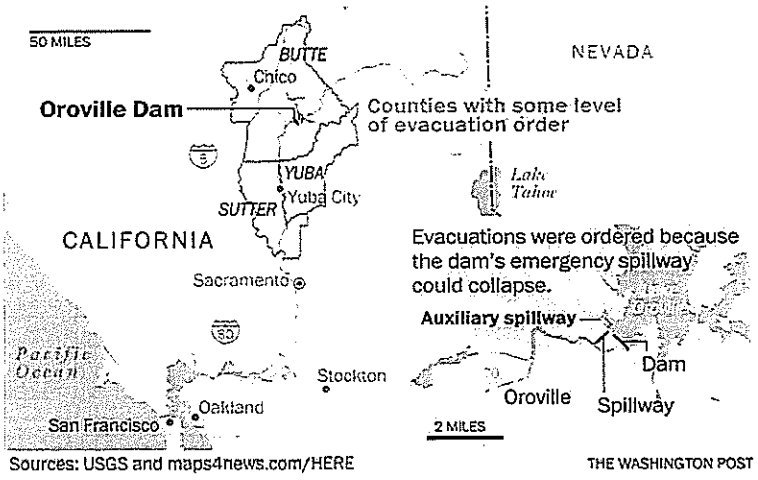
Source: California Department of Water Resources

Sacramento Bee/Nathaniel Levine

From Bad to Worse

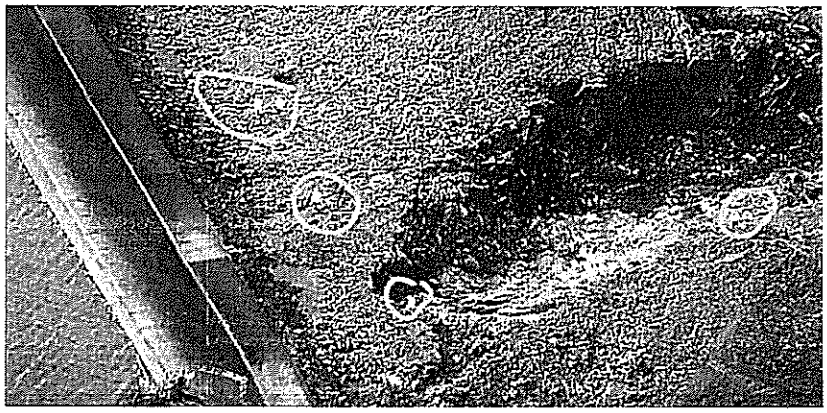


And Near Catastrophe



Imminent Failure, Day After

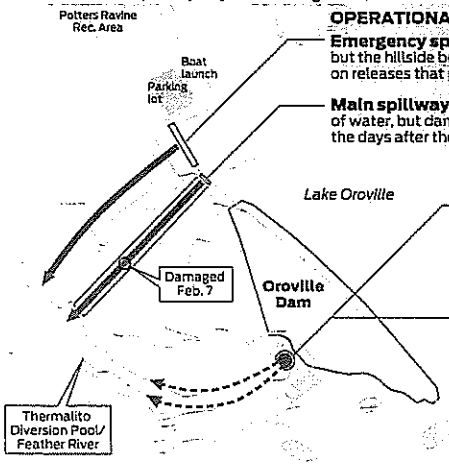
Imminent Failure, Day After



All outlets compromised

Outflows at Oroville Dam

Lake Oroville has four primary ways of releasing water, all of which were compromised last weekend.



OPERATIONAL

Emergency spillway: Used for the first time over the weekend, but the hillside began dangerously eroding within a day after taking on releases that peaked at 12,600 cubic feet per second (cfs).

Main spillway: Damaged Feb. 7, can release up to 150,000 cfs of water, but dam operators were releasing about 100,000 cfs in the days after the spillway was damaged.

NOT BEING USED

Edward Hyatt Powerplant: 14,000 cfs can push through the hydroelectric plant at the base of the dam when operational, but it was turned off to prevent it from being damaged after the main spillway was damaged.

River outlet: Located lowest in the reservoir, regulates cold-water releases. It had an original capacity of 5,400 cfs but has largely not been used since it was involved in a 2009 accident that injured dam workers. Officials say it can now release up to 2,000 cfs.

Source: State Department of Water Resources

John Blanchard / The Chronicle

Short-term Recovery Actions

Dredging out Oroville Dam afterbay to relieve pressure on powerplant and enable restart

Rerouting powerlines to avoid danger zones and keep powerplant on line. Reroute major PG&E transmission line

Stabilize auxiliary/emergency spillway hilltop

Shorterm stabilization of dangerous erosion features to main spillway

Next One or Two Construction Seasons

Stabilize and reconstruct the main spillway

Construct spillway on emergency/auxiliary hilltop (without hillside spillway still an incomplete spillway causing havoc if used)

Potentially permanently rerouting powerlines to avoid danger zones and keep powerplant on line. Redundant powerlines

Following Construction Seasons

Construct full spillway to prevent severe hillside erosion if used. (Without explicitly stating so, as of this writing DWR apparently has rejected this necessary fix.)

Ensure that radial gates have sufficiently redundant power. (Not sure this will be assessed for need or undertaken since Bulletin 200 description may not represent current conditions.)

Find a way to increase reliability and capacity of low level outlets and powerhouse releases and increase their capacity (Relying on powerhouses to reliably make reservoir regulation releases can be tricky business.)

Consider construction of a lower-level outlet/spillway capable of making releases in advance of extreme storm inflow.s (Although Oroville's low-level flood-release capabilities aren't bad, they may need to be improved if a complete emergency spillway option is selected and the surcharge flood reservation has to be transferred to the conservation pool.)

Identify and fix other identified problems that may threaten the infrastructure and the operability of the Oroville Dam complex (for example, there may be some through-dam seepage that may need attention)

Forensic Investigation

FERC Dam Safety has asked DWR to conduct a study to determine the cause of the spillway failures

Much of DWR and FERC's in-progress thinking is behind a veil of CEII secrecy. DWR has proposed to make the report public (although parts will be redacted)

It is unclear if the review will determine the causes of DWR and State and Federal Dam Safety official's failure to discover or appreciate havoc-causing or dam-safety issues during design, life of project, or licensing review. This may involve sociologic factors

Major Unresolved Problems

Likely resistance of State Water Contractors to paying the bill for reconstruction and appropriate levels of maintenance

DWR and Dam Safety Regulator's view that emergency/auxiliary spillway use or operational need is extremely unlikely (even to 1/10,000 or 1/100,000 annual risk levels, although Oroville has either been told to evacuate or evacuated twice in life of project because of feared use)

Much of DWR and FERC's in-progress thinking on forensics and design is behind a veil of CEII secrecy. DWR has proposed to make the forensics report public (although parts will be redacted)

Major Consequences

Veil of secrecy prevents public from informed consultation with DWR and FERC on reconstruction and making the Oroville Dam complex safe decisions

DWR, state and federal dam safety officials, and FERC licensing appear to have no concept that havoc-causing or unsafe emergency/auxiliary spillway design defeats the likelihood of ACE-required managed floodwater-management surcharge releases from the dam. The result: decreased flood protection for downstream communities

Solutions

This incident highlighted a major failure of dam-safety regulators (state and federal). This should be a major focus of at least one influential forensics report. The report(s) should recommend reforms and they should be adopted

Contracts with state water contractors should cover costs of ongoing maintenance and addressing design deficiencies that affect project operations, safety, reliability or other necessary programs.

DWR and Federal regulators need to quickly construct a more reasonably transparent Oroville Dam complex reconstruction and rehabilitation process that allows an informed public to affect design decisions now being undertaken in considerable secrecy (this might not have been necessary if DWR and the State Water Contractors had not fought off reconstruction and rehab during relicensing)

Final Reflections

Dams, although much praised for their functions, are also dangerous. The legislature and water agencies should be more cautious about authorizing or funding them just assuming that dam-safety and environmental decisions will be made responsibly. The failures at Oroville should have been caught during design, through dam safety reviews, during contract reviews, during relicensing, and even the 2017 process. The weren't in the past, and some appear not to be heading for a satisfactory conclusion either in 2017 or in the coming years.

The Oroville Dam Spillway incident drew worldwide press. California and FERC need to understand that they need to resolve all of the deficiencies, both physical and institutional, if we are to be viewed as the world leader we aspire to be. On the transparency front, it is not an auspicious start.

Photo Credits

San Jose Mercury News
Associated Press
Department of Water Resources
Wikipedia
Sacramento Bee
Dave Gutierrez, GEI Consultants, recently retired chief of the DWR Division of Safety of Dams
Los Angeles Times
San Francisco Chronicle
Washington Post

(It should be noted that some of these photographers headed into the evacuation zone, risking their lives to "get the story.")

For more information, contact:

Ron Stork
Policy Director – Friends of the River
Phone: (916) 442-3155 x220
Email: rstork@friendsoftheriver.org

For some of this information, visit the Oroville Dam page at
www.friendsoftheriver.org
http://www.friendsoftheriver.org/our-work/rivers-under-threat/feather-threat/

EXHIBIT 3

The Editor,
Mercury – Register/Enterprise – Record,
letters@chicoer.com

February 25 2019

Risks at Oroville Dam

Recently, there has been press coverage of the failure of a second tailings dam in Brazil. This should remind us of the risks associated with the Oroville Dam.

The CEO of Vale, Brazilian dam owner, commented that *'we acknowledge the deficiencies in scientific and technical understanding'* and that *'nuclear industry safety measures, monitored by an independent body are required'.*

In contrast, after the spillway failure, Joel Ledesma DWR's Deputy Director told NBC *'we have a very good seepage monitoring system at the Oroville Dam already and in our opinion it's reliable. It would catch any leak'.* The original piezometers, which measure pressure and seepage, have been abandoned and we have seen no data to support this conclusion.

The November 2018 FERC After Action Panel report characterized the DWR's approach as *'a compliance rather than a safety program'* and its *'failures seem to be of a systematic or cultural nature'.* Scientific methods are not routine, let alone a nuclear level of safety measures or independent monitoring.

DWR should operate the Dam so that they earn our trust. Transparency is needed. DWR should say what they are doing, tell us why they think we are safe, and tell us why we should believe them.

The lake level is rising to the unreliable spillway gates. At this level last year, the partially completed spillway leaked and the 'green spots' always appear. DWR representatives have said that, if possible, the lake will be filled this year. This would not be responsible management.

Sincerely

Robert Bateman
Secretary Feather River Recovery Alliance

94 Stringtown Rd,
Oroville, CA 95966
530 370 3347

EXHIBIT 4

PATRICK PORGANS & ASSOCIATES, INC.

GOVERNMENT REGULATORY INTERVENTION ... TO HOLISTIC RESOURCE CONVERGENCE

Telephone: (916) 374-8197 Fax 372-7679 P.O. Box 1713, W. Sacramento, CA 95691

REVISED SUMMARY REPORT
February2004
To: The Federal Energy Regulatory Commission and All Members of the Plenary Group

Project: California Department of Water Resources' (DWR) Relicensing of the State Water Project's Oroville Facilities – Federal Energy Regulatory Commission (FERC) Project 2100
Subject: Notification to Plenary Group of Porgans & Associates Decision to Suspend Participation in the Alternative Licensing Procedure (ALP) and of Our Intent to Inform FERC and the Public of the ALP's Inherent Shortcomings, which are Diametric To Meaningful Public Input, Government's Trust Responsibilities and the California Department of Water Resources' (DWR) Written Assurances

DWR's Actions in Conflict with Assurances to Plenary: The tactics employed by DWR's management-level personnel were inconsistent with the assurances that they agreed to from the onset of the process; i.e., cooperation/collaboration, trust, consensus, transparency, and above all DWR's written assurances that the Plenary Group was to *serve as the forum in which to ultimately decide the terms of the settlement agreement.* Conversely, the records will attest to the fact that in matters of critical importance to the local participants and several federal agencies, DWR was less than cooperative, recalcitrant, and in some instances non responsive. Furthermore, as was pointed out by an objective observer (a skilled facilitator familiar with FERC relicensing procedures), who inform P&A and others, that the department's demeanor at the Plenary meetings which he had attended was combative and not collaborative.

Notification: Porgans & Associates (P&A), Inc., is compelled to formally notify the Plenary Group and the Federal Energy Regulatory Commission (FERC) of our intent to suspend participation in the Plenary Group due to the inherent shortcomings of the ALP that are diametric to meaningful public input and government's trust responsibilities. In good conscience we cannot be a party to a process that for all intent and purpose is perfunctory, disingenuous and in conflict with the public's interest and DWR's written assurances to the Plenary Group. On numerous occasions, P&A and other participants requested DWR to address longstanding concerns and issues regarding the inherent shortcomings of the ALP; i.e., who and what constitutes consensus (who should be involved in consensus decisions), collaborative/cooperation, trust, transparency, cumulative impacts study plan, DWR's failure to adhere to written assurances, and its evasive and combative tactics that lack a collaborative spirit . To DWR's credit, it did attempt to address some of the issues; however, it failed to reconcile the majority of the critical issues and concerns raised consistently over a three-year period.[1]

---

[1] Porgans & Associates' communication to Plenary Group, Project: Department of Water Resources Oroville Facilities Relicensing – Plenary Meeting, Subject: P&A's *Perspective, Concerns and Suggestions Regarding the ALP*. May 1, 2001.

P&A's written communication to All Members of the Plenary Group. Project: California Department of Water Resources Relicensing of the SWP's Oroville Facilities, Subject: *Issues of Concern and in Need of Clarification and Interpretation*, Preliminary Draft, Oct. 22, 2002.

P&A's written communication to Patti Kroen (Facilitator) and All Members of the Plenary Group, Project: California Department of Water Resources Relicensing of the SWP's Oroville Facilities, Subject: *Issues of Concern and in Need of Clarification and Interpretation at the Plenary Level*, Final, Jan. 17, 2003.

P&A's Meeting with DWR Officials, Resources Building, 1416 Ninth Street, Rm. 1603, Sacramento, California, Subject: Oroville Facilities Relicensing: Plenary Action Item Meeting Agenda (Off-Line Discussion), Sept. 12, 2003.

P&A's Fax to Mary Nichols, Secretary of Resources and Mike Spears, Interim Director, California DWR, RE: *Department's Solicitation for Solutions to an Apparent Breakdown in Its FERC Alternative Relicensing Process for the Oroville Facilities*: Resolution of Impasse Concerning Fairness, Trust and Confidence, Oct. 15, 2003.

Seismo Blog

Oroville Dam Makes its own Earthquakes

Categories: Northern California (/blog/all_posts_by_category.html#Northern California) | Preparedness, Risks, and Hazards (/blog/all_posts_by_category.html#Preparedness, Risks, and Hazards) | Induced Seismicity (/blog/all_posts_by_category.html#Induced Seismicity) | Reservoir Induced (/blog/all_posts_by_category.html#Reservoir Induced)

February 16, 2017

The immediate danger to the highest dam in the United States, the Oroville Dam, is over - at least for now. While more than 180,000 people who had been evacuated along the Feather River downstream from the dam were able to return home earlier this week, the future of the 770 foot high earthen dam in California's Butte County is all but secure. The intense rainfall expected with the current storm, the heavy snowmelt in the spring and even earthquakes are a threat to the dam. In the previous blog, we described the kind of severe damage earthquakes can cause to earthen dams using the Van Norman Dam north of Los Angeles as an example. Although its construction is different than that of the Oroville Dam, it barely survived severe seismic shaking from the San Fernando earthquake of 1971 (blog/2017/02/09/today-in-earthquake-history-san-fernando-1971.html). That quake occurred on an unknown fault, while the Oroville Dam is no stranger to earthquakes - in fact, it has caused its own quakes. But let's start at the beginning.

Construction of the dam began in 1961 and the dam, with a crown almost 7000 feet long, was completed six years later. On November 14, 1967, the final diversion tunnel was closed and water storage began. In 1963, during construction of the dam, seismologists from the U.S. Coast and Geodetic Survey installed a seismic station about 0.4 miles north of the dam. They used what was then top of the line seismic monitoring equipment. Experts at UC Berkeley's Seismographic Stations - the predecessor to our own Berkeley Seismology Laboratory (BSL) - were tasked with analyzing the recordings.

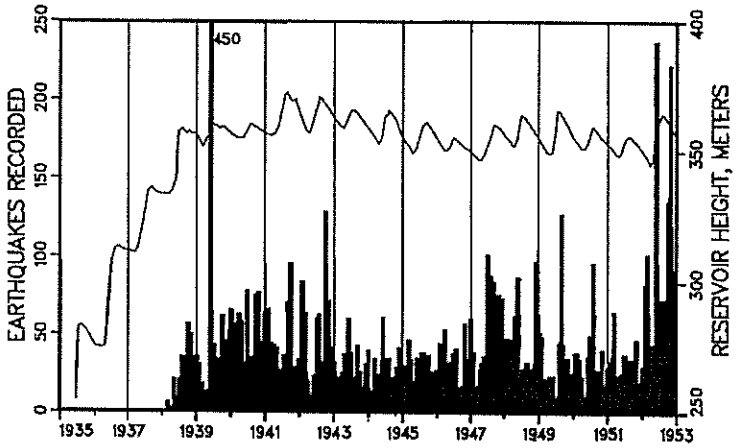


Figure 1: This 60 year old historic document shows the induced seismicity created by the filling of Lake Mead behind Hoover Dam. The black bars depict the number of earthquakes per year (left scale). The wiggly line shows the water level in the lake (right scale). Earthquakes started abruptly in 1938 when the lake was almost full.

The observant reader of the Seismo Blog may ask why a seismic station was built in an area of California with among the lowest known seismic

hazard in the entire state. Historically only two significant quakes with estimated magnitudes between 5 and 6 are known to have occurred in the area, one in January 1857 near the city of Oroville and the other one in February 1940 about 40 miles to the north. The reason to build the seismic station labeled ORV near the dam dates back almost 90 years. Between 1926 and 1932 the concrete Qued Fodda Dam was built in Algeria. While the reservoir gradually filled with water, many small earthquakes happened in the area around the dam. These small temblors were a mystery, because like the area around Oroville, this region of Algeria was not seismically active.

Nevertheless, dam engineers took note and when the Hoover Dam was built between 1931 and 1936 as a flagship project in the US, seismic sensors were placed in the vicinity of the dam. And indeed, two years after the impounding of the Colorado River behind Hoover Dam began, large numbers of small earthquakes started to occur around Lake Mead. The number reached more than 400 in the first year alone (see Figure 1). By now, this phenomenon, which correlates water levels in reservoirs with the number of local earthquakes, is well studied and understood. It is called induced seismicity.

Every piece of rock underneath our feet contains some water in its pores, the little, sometime microscopically small voids between its mineral components. When extra water gets into these rocks, the pore pressure inside rises, ever so slightly increasing the distances between the mineral components. However, if the rocks are crossed by a dormant fault, the increase in pore pressure decreases the friction along the fault and may allow an earthquake to happen. That's what happened in Algeria and behind Hoover Dam. The extra pressure exerted by the impounded water changed the pore pressure in the rocks and dormant faults were activated.

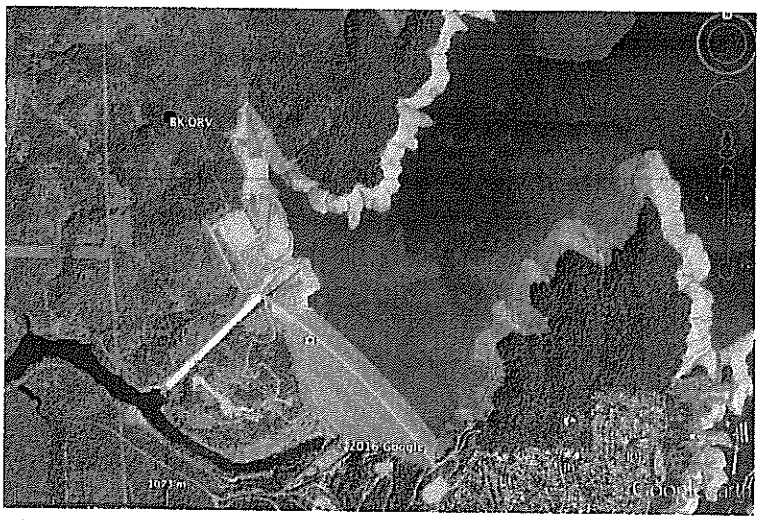


Figure 2: This Google Earth image from last year shows the Oroville Dam and the location of Berkeley's seismic station ORV, less than a mile north of the dam. The dam's concrete spillway is still intact. Note the low water level in the lake as indicated by the brown bathtub ring immediately above the water line. Today, Lake Oroville is at capacity.

Engineers building the Oroville dam wanted to know if such induced seismicity would occur behind their dam as well, and thus they built seismic station ORV. The reservoir was first filled to capacity in July 1969 - and nothing happened for almost six years. The seismic sensors did not record any uptick in seismic activity around Lake Oroville. That changed suddenly on June 28, 1975, when a magnitude 3.5 quake occurred south of the lake. During the month of July, it was followed by almost 20 minor shocks in the same region, until a magnitude 4.7 quake hit on August 1. It was followed in turn by a magnitude 5.7 quake, which was felt in large parts of northern California and even in Carson City, Nevada. The quake caused light damage to buildings in the city of Oroville, but left the dam untouched. After another month or so the earthquake swarm subsided.

Why did it take so long for Lake Oroville to show any signs of induced seismicity? This question has never been fully answered, but the current hypothesis goes as follows: During the winter of 1974/75, large amounts of water were released from the lake to make room for the snow melt in the spring of 1975. During the spring, the lake refilled very quickly. The theory is that the rapid change in hydrostatic pressure somehow affected a dormant fault south of the lake. A similar rapid change in the lake level has occurred in the past few weeks. After six years of drought, the lake level had fallen dramatically, only to rapidly increase due to the rainfall and runoffs in the last few weeks.

So the question is: Are we in for a new bout of induced seismicity like that seen 41 years ago? Nobody knows, but if it happens, the modernized seismic station ORV will take notice. After 53 years it is still working and transmitting its data to the BSL (see Figure 2). In fact, during the current crisis, its sensitive seismic sensors have been recording ground vibrations caused by the torrent of of water roaring down the two spillways. These vibrations were so strong that they mask any weak signals of ground shaking that might be caused by tiny earthquakes. (hra136)

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EXHIBIT 6

Robert Bateman

From:	Robert Bateman
Sent:	Monday, October 14, 2019 12:18 PM
To:	Nemeth, Karla@DWR
Cc:	Richard Thompson; Genoa Widener; Yarbrough, John@DWR
Subject:	Information provided by DWR Representatives at the Citizen's Advisory Committee

Dear Ms. Nemeth,

It was a pleasure meeting you last week. The meeting was valuable. It was particularly encouraging that you and Secretary Crowfoot attended. You suggested that you would not mind my e-mailing you if I thought this would be helpful.

Some of the information provided, and the comments made, by DWR people, during and after the meeting did not appear to be accurate: the spillway gates and leakage are examples.

Ted Craddock stated that leakage from the gates was caused by debris. Also, when I mentioned the decrepit state of the gates and gate structure to John Yarborough he asked 'what is wrong with the gates, they worked didn't they?'. The spillways with their known defects also worked—until they didn't.

It is clear to anyone listening to the deliberations of the CNA 'Ad Hoc' Committee that the DWR engineers know that the gates and gate structure need renovation but that, although serious, this is not necessarily the highest risk problem with the dam.

Since the meeting, I have reviewed the literature and spoken to dam professionals to get informed opinions of why spillway gates leak and specifically what is the likely cause of leakage at the Oroville gates. I learned that the key issues associated with leakage at spillway gates do not include debris, intuitively that seems unlikely since the water entering the gates is normally drawn from hundreds of feet below the surface. At Oroville, the key issues affecting leakage that have been identified by both the DWR and FERC in their inspections and analyses of inspection results are:

- the cracked reinforced concrete structures that support the gates, and
- the cracked control rods that are used to open and close the gates.

That is to say, the gates leak because of age and they need renovation.

This is just one example of the way senior DWR managers as well as DWR and SWC PR people ignore or, worse, manipulate the facts when they are speaking to the community. Their intentions may be well meaning but it will be impossible to establish trust in the DWR so long as this continues. It will be impossible even to have meaningful conversations. The credibility of the Citizens' Advisory Committee will not last long if this sort of information is provided and expected to be believed.

The widely held view is that these spokespeople are following a DWR policy not to trust the community with the facts. If so, it is surprising that this policy has survived after the totally misleading, simplistic, strongly asserted information put out by the DWR right up to the time of the collapse of the spillway and the erosion of the emergency spillway.

There are bound to be vulnerabilities and, after the Spillway Incident, everyone around here is concerned about them. Getting the vulnerabilities out in the open with an honest exchange of ideas from DWR and other dam professionals on how they can best be minimized is the way to build confidence in the DWR, not expecting us to believe the unbelievable.

I mentioned to you and others the possibility of holding a seminar on Dam safety or perhaps seepage through earth dams. This was also raised during our meeting with Joel Ledesma. This could be organized through a University and include papers from dam professionals as well as the DWR. Constructive participation by the DWR would give people reason to trust the DWR. Will you support this?

Our hope is that the DWR recognizes and appreciates the potential seriousness of the remaining defects in the Dam, will move to remediate them swiftly and will control the lake level to minimize the risk of failures until they can be fixed.

Sincerely,

Robert
Secretary Feather River Recovery Alliance

EXHIBIT 7

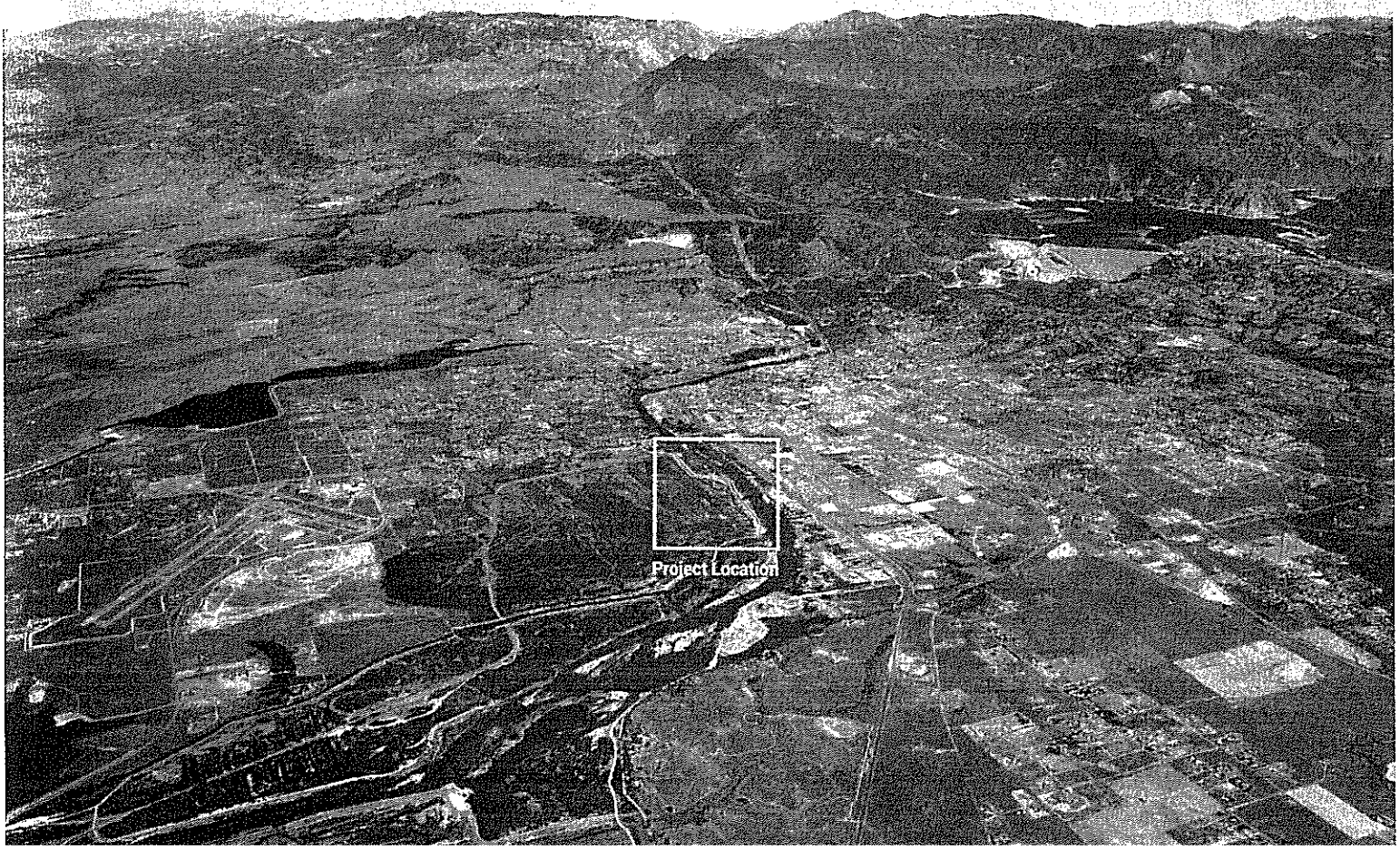
Spillways Restoration & Community Revitalization:

This document presents a potential multi-benefit flood and ecosystem project in the Oroville Wildlife Area along the Feathe River to achieve multiple benefits—locally and regionally. The project would be a highly cost-effective way of increasin public safety and reducing the possible loss of life and property during a major flood event. The flood attenuation site woul also create high-quality habitat for threatened and endangered species, as well as providing the residents of Californi with enhanced recreational opportunities for hunters, fishers, birders, kayakers and other outdoor activities. If planned an configured appropriately, the project will also support 2018 Oroville Spillways recovery and restoration (making that effor cheaper, more sustainable, and more expedient), may be configured to achieve implementation of key parts of the pendin Federal Energy Regulatory Commission (FERC) license, and can strengthen partnerships with the Oroville community.

Location & Background

The State-owned Oroville Wildlife Area (OWA; see photo below) is approximately 11,800 acres in size and is located immediately southwest of the City of Oroville. The Feather River transects the site and runs nearly 10 miles through the OWA. The Feather River and its floodplain in the OWA were altered by large-scale bucket-line gold dredge mining that occurred from 1898 to 1952. Today, nearly 5,000 acres of the OWA, in places measuring nearly 2 miles wide (east/west) by more than 7 miles long (north/south), consists of large areas primarily composed of the remnants of dredge tailings and associated features. The dredging removed vital topsoil and the resultant gravel/cobble tailings piles (some as tall as 50 feet or more above the river) have created a moonscape that locals hav decried in public meetings as "an ecological travesty." Once used t keep the un-dammed Feather River from disrupting gold dredgin operations, the upstream portions of the tailings configured int a now-obsolete flood control "levee!" is an eyesore that als diminish habitat for fish and birds by constricting flood flows ont neighboring lands, eliminating vital flood flows from engaging th floodplain. This highly disturbed topography also increases floo stages in the Feather River and exacerbates flooding in the soutl Oroville industrial area, east and west of Highway 70.

1 The feature envisioned for removal in this project is not a FEMA-accredited levee, nor is it a USACE Project levee or a part of the State Plan of Flood Control.



The Project

The project itself is a relatively-simple aggregate excavation and sediment sorting project. The project's "multiple benefits" are created with the appropriate location and configuration of the excavation, along with the sorting and use of the excavated material and subsequent site revegetation. The project would excavate an obsolete tailings pile (presently configured in a sort of "levee" that protects nothing other than other mine tailings) on the right-bank[2] of the Feather River in the OWA (see figure at right). The resultant land surface would be configured to create a naturalized floodplain surface that would increase the channel's flood capacity, would allow flood flows to move into and attenuate in the newly-opened floodplain, and this new floodplain and river connection would greatly help juvenile salmon and steelhea by providing increased and improved rearing habitat. In orde to provide for decreased costs for 2018 Spillways work, DW would place a performance specification into subsequer designs/bid packages requiring the contractor to mine an process the material for the spillways project from this State owned location. The configuration of the excavation an associated restoration would need to be carefully planne and executed to meld with and achieve other State- an locally-driven plans and goals. Importantly, the appropriat planning and collaboration necessary to complete the proje and achieve all benefits must be initiated immediately t achieve requisite timelines and maintain credibility[3].

2 As viewed from the perspective of looking downstream.

3 In October, DWR announced and filed with the FERC notification that up to approximately 80,000 cubic yards of aggregate will be extracted from the OWA for use as pervious drain material in Spillways repairs, with this work anticipated to commence mid-December 2017. However, that 80,000 CY of material is planned to be extracted far from the riv and will not provide the multiple benefits noted here; and DWR didn't clearly articulate that their project is NOT the same project described here / that has been discussed by th local community for the last 6 months. That ambiguity has further eroded confidence in the Department and to some locals feels like "bait and switch".

The Project's Multiple Benefits

Multi-benefit flood projects such as this one are designed to both reduce flood risk and benefits such as protecting downstream cities and farms, improving water quality, increas related measures and Spillways repairs. The project also offers the opportunity to streng

Flood Benefits:

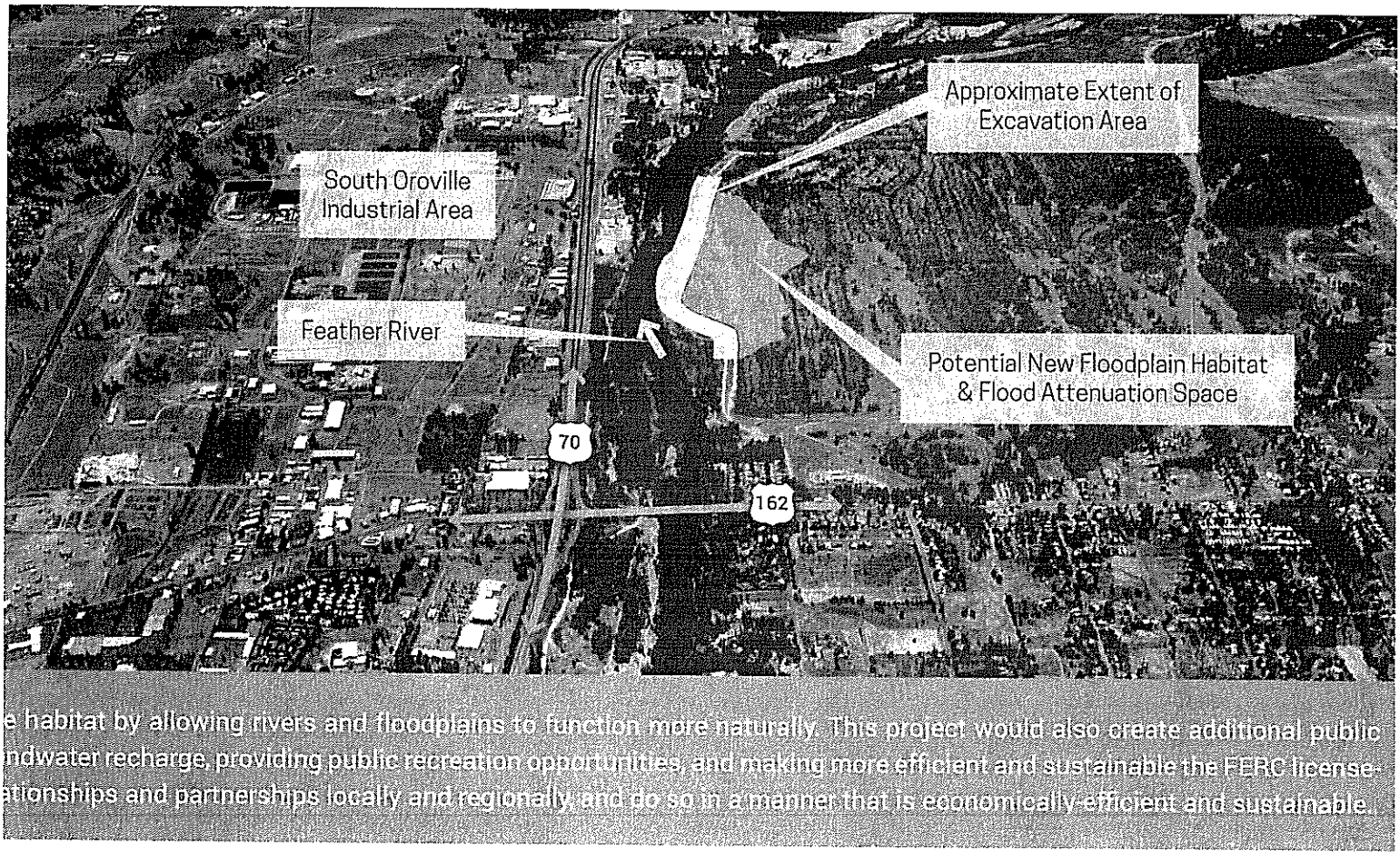
- **Locally increased flood conveyance and decreased flood water surface elevations,** reducing flood hazards for Highway 70 and the adjacent industrial area. Businesses would benefit from being able to regain flood insurance, lost after the 2017 flood releases.
- **Attenuation of flood flows for downstream cities and farms.** Increasing flood flows down the Feather River would expand out into the floodplain, delaying the rise in the hydrograph for downstream locations. Delaying this peak flow would reduce downstream water surface elevations for a time, potentially eliminating levee failures and also would providing emergency responders with extra time needed to prepare and/or safely evacuate downstream communities, as appropriate.
- **Alignment with the CVFPP 2017 Update.**
- **Likely no expansion in FEMA mapped floodplains.** The area behind the existing, obsolete "levee" is already subject to inundation when the highest flood flows backwater into the site. This project would simply remove the constriction by this levee, lowering water surface elevations in the river and allowing flows to expand into the floodplain, increasing the frequency and duration of floodplain inundation.

Ecosystem Benefits:

- **Restoration in the OWA.** Without active restoration, recovery from the legacy of Gold Rush impacts will be on a geologic timescale. This project is a critical first step that is long overdue.
- **Restoration of vital rearing habitat and refugia for threatened and endangered fish species.** With upstream Oroville facilities limiting spawning and rearing habitat, this floodplain project will increase critical habitat and rehabilitate key geomorphic processes that create and (importantly) maintain these habitats for fish and avian species.

FERC License Benefits:

- **Supports DWR completing Settlemen Agreement/FERC License Articles A1 A103, A104, A106, and potentially A1**
- **Provides increased floodplain habitat opportunity for side channels for A10 A103 and A104.**
- **Floodplain-width (oscillation) in this project can be designed to enhance riffle sediment retention in support o A102. This decreases the long-term O requirements on this habitat, decreas total costs on A102.**
- **Portions of the excavated material ca sorted and used for gravel augmenta support A102 and for Spillways repai**
- **Floodplain can be configured to supp development of a pilot (and long-term count and/or segregation weir for A1**



e habitat by allowing rivers and floodplains to function more naturally. This project would also create additional public ndwater recharge, providing public recreation opportunities, and making more efficient and sustainable the FERC license- ationships and partnerships locally and regionally, and do so in a manner that is economically efficient and sustainable.

Spillways Repair Benefits:

- **A local source of aggregate for Spillways repairs** and/or upgrades, **decreasing GHG emissions** for materials transport, **lowering costs**, while simultaneously providing an immediate use for excavated floodplain material that cannot be used for spawning gravel augmentation. This is a **sustainable** approach to this project and the Spillway repairs.
- **Eliminates the long haul distances from the Yuba River aggregate/sand operations** presently being used on the Spillways. One truck driver working on the Spillways project died in a crash on Highway 70 in March (since termed "Blood Alley," per highway billboards). Aside from GHG emissions and economics, reducing Highway 70 construction traffic by sourcing material locally is the right thing to do.

Economic Benefits:

- **Elimination of aggregate purchasing and decreased transport costs for ensuing Spillways repairs.**
- Integration of material sourcing for the Spillways repairs with implementation of the Settlement Agreement/FERC License Articles, **yields large cost savings and efficiencies for DWR and the SWC**:
  - Short-term savings come from lower material costs for the Spillway; long-term savings comes from completing FERC measures sooner than later, thus spending cheaper dollars/on lower costs to complete these measures.
  - Importantly, use of material from the OWA is a highly-efficient way to complete the Spillways repairs and complete FERC with the same dollars.
- **Decreases flood insurance/allows for flood insurance for local businesses** in the Highway 70/South Oroville Industrial Area
- Implementing the **A105 segregation weir** (separating listed fish runs from those that could be available for the sport fishery) **could support changes in the Fish and Game Code to allow for increased fishing opportunities** for salmon and steelhead in the Feather River, **increasing recreation and spurring economic recovery**

Partnerships:

- This project is **supported by the local Oroville Strong! stakeholders and the Oroville Dam Coalition** because it improve habitat, decreases flood hazard, is efficien and promotes sustainability at multiple levels, and could save the SWC and DWR money if implemented appropriately. It is viewed locally as a "no-brainer" and a "win win."
- **Opportunity for partnership and a strateg "win" for DWR/SWC in collaborating with Oroville locals.**
- A **foundational first step at reconciling past practices that have decimated a critically important floodplain along one of California's most important rivers**, and a respectful and practical offering in addressing the environmental justice issu that plague the legacy of Oroville Dam.
- Supports making **early progress on FERC License implementation** by integration of ecosystem items into the spillway recovery. With an eye toward endangered species recovery, several NGOs are seekin to expedite the ecosystem restoration elements of the FERC license—leaving issues related to the Project's facilities (i.e the Spillways and Dam) to the side for nov

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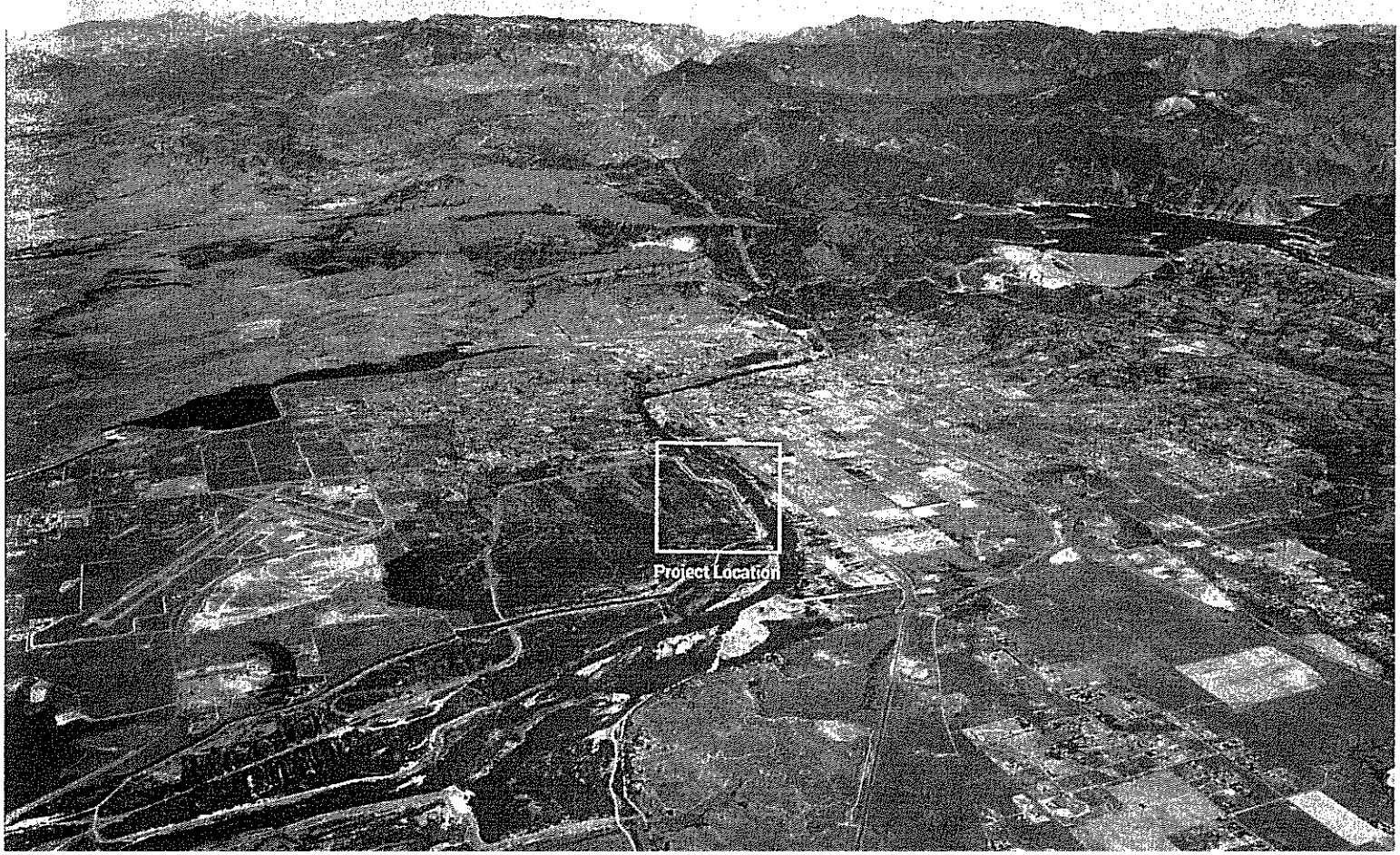

PBS NEWS HOUR

EXHIBIT 8

In an era of extreme weather, concerns grow over dam safety

Science Jul 16, 2019 2:03 PM EDT

It is a telling illustration of the precarious state of United States dams that the near-collapse in February 2017 of Oroville Dam, the nation's tallest, occurred in California, considered one of the nation's leading states in dam safety management.

The Oroville incident forced the evacuation of nearly 190,000 people and cost the state **$1.1 billion in repairs.** It took its place as a seminal event in the history of U.S. dam safety, ranking just below the failures in the 1970s of two dams — Teton Dam in Idaho and Kelly Barnes in Georgia — that killed 14 and 39 people, respectively, and ushered in the modern dam safety era.

The incident at the half-century-old, 770-foot-high Oroville Dam, which involved partial disintegration of its two spillways during a heavy but not unprecedented rainstorm, signaled the inadequacy of methods customarily used throughout the country to assess dam safety and carry out repairs. It occurred as federal dam safety officials have made substantial progress in updating methods of dam assessment, in the process propelling dam safety practices into the 21st century.

But federal and state dam safety officials have been unable to procure from disinterested state legislatures and Congress the tens of billions of dollars needed for repairs to the nation's aging dam infrastructure.

Largely as a result of the funding shortfall, in its latest infrastructure report card, in 2017, the American Society of Civil Engineers (ASCE) gave the nation's 91,000-plus dams **a D grade**, the same grade they have received in every ASCE report card since the first one was issued in 1998. The ASCE estimated the cost of rehabilitating dams whose failure would threaten human life at nearly $45 billion, and the cost of fixing all dams in need of repair at more than $64 billion. This year, the Association of State Dam Safety Officials (ASDSO) arrived at an even higher number — **nearly $71 billion for all dams.**

"There's a huge backlog of rehabilitation needs regarding dams in our country," said Lori Spragens, ASDSO's executive director. "Regular citizens are unaware that the dams around them may be risks, and there's not enough public awareness for people to be prepared, just like they would be for a tornado or an earthquake."

And scientists say the likelihood of dam failures — which not only threaten lives but also release toxic sediments trapped in reservoirs behind many dams — will increase as extreme precipitation events become more frequent in a warming world.

Aside from about 1,500 dams owned by federal agencies, regulating dam safety is chiefly a state responsibility, and states vary widely in their commitment to the task. Across the nation, each state dam inspector is responsible on average for about 200 dams, a daunting ratio, but in some states the number is much higher. Oklahoma, for example, employs just three full-time inspectors for its 4,621 dams; Iowa has three inspectors for its 3,911 dams. Largely because of its legislators' distrust of regulation, Alabama **doesn't even have a safety program** for its 2,273 dams.

States require inspections of "high-hazard-potential" dams, whose failures would cause fatalities, every two-and-a-half years on average, but actual inspection intervals are much longer. Eleven states don't inspect "low-hazard-potential" dams — dams that don't threaten lives or property — at all.

Among states given high marks for their programs are Pennsylvania, New Jersey, Colorado, Washington, New Mexico, and, at the top o most lists, California, which spends the most of any state on dam safety, **more than $21 million** in 2017. Yet an **independent report** on the causes of the Oroville incident published in January 2018 faulted California's dam safety practices in numerous ways.

While the dam was inspected regularly, safety officials failed to look more deeply into the dam's history, and consequently missed deficiencies in its main spillway that stemmed from its design and construction. California's Department of Water Resources was

An aerial view of the damaged Oroville Dam spillway in California, and the debris field just below, in February 2017. Photo by California Department of Water Resources

"overconfident and complacent about the integrity" of its dams, and was "chronically" understaffed, the report said. And the department lacked expertise in dams' secondary structures, such as the failing spillways.

"The fact that this incident happened to the owner of the tallest dam in the United States, under regulation of a federal agency, with repeated evaluation by reputable outside consultants, in a state with a leading dam safety regulatory program, is a wake-up call for everyone involved in dam safety," the report said. "Challenging current assumptions on what constitutes 'best practice' in our industry is overdue."

Until the 1970s, information about the nation's dams was scant: some hadn't been inspected for decades, and nobody knew how many existed. After numerous dam disasters, the nation's **first dam inventory** in the early 1970s established the existence of nearly 90,000 non-federal dams, most of them small. Inspections of about 9,000 of them found that a third were unsafe. Since the federal government had no responsibility for those dams, the states then began to take their dam safety responsibilities seriously.

Dam safety programs are generally considered to have improved since then, but dam failures — the rapid, uncontrolled release of water when dams are breached or collapse — are still frequent. According to the ASDSO, between January 2005 and June 2013, state dam safety programs reported 173 dam failures and 587 "incidents" — events that probably would have resulted in failures if not for quick interventions.

Fatalities caused by dam failures are far less common. Since the collapse of the Kaloko Dam in Hawaii in 2006, which killed seven people, no deaths occurred until this March, when Nebraska's Spencer Dam, just 29 feet high, gave way to epic floodwater, sweeping away a house with a man inside it in the floodplain below.

One sure way to eliminate a dam's danger is to dismantle it, but the impact on safety of the budding U.S. dam removal movement has been minimal. One reason is that most of the removed dams were small, less than 25 feet high; another is that relatively few dams have been removed. Last year marked a high point, with **99 dams taken down**. But that number represents only about a thousandth of the nation's dam stock.

Conservation groups and anglers' organizations such as Trout Unlimited have led the drive to take down U.S. dams, often to help restore long-blocked fish migrations. These groups note that removing a small dam may cost less than repairing it. But removing a large dam can cost as much as building it in the first place. Efforts to dismantle large dams on major rivers, such as the Snake River in the Pacific Northwest, have faced strong resistance from business groups and utilities, which defend the dams for generating hydropower and creating reservoirs used to ship grain and other commodities.

READ MORE: After a long boom, an uncertain future for big dam projects.

As sobering as the problem of dam safety is in the United States, consider that aside from Australia, Canada, and Western Europe, dam safety standards in the rest of the world lag behind the U.S. Catastrophic failures are frequent: Since August 2008, when a dam in Nepal gave way, killing 250 people, at least 10 dam failures have each killed 10 or more people. In January, a mining dam in southeastern Brazil collapsed, killing about 300 people. Last year, a dam under construction in Laos crumbled, killing 40 people and leaving 6,600 homeless, and a dam in Kenya burst, killing 48 people.

Members of a rescue team search for victims after a tailings dam owned by Brazilian mining company Vale SA collapsed, in Brumadinho, Brazil January 28, 2019. Photo by REUTERS/Adriano Machado

In the U.S., three interlocking developments have impeded improvements in dam safety in recent decades. First, the nation's dams are growing old: **their average age is 57.** By that age, seepage can start to erode dams' foundations — the U.S. Army Corps of Engineers spends about $200 million a year to address seepage on its dams alone. And parts such as spillway gate, motors, winches, and generators wear out and need replacement.

Second, dams are vulnerable to so-called "hazard creep": their danger increases as developmen occurs downstream. A dam that was rated "low-hazard-potential" when it was built because nobody lived in the floodplain below may become a "high-hazard-potential" dam once people move into the area. As a result, even though new dam construction in the U.S. virtually stopped i

PBS NEWS HOUR

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But federal and state dam safety officials have been unable to procure from disinterested state legislatures and Congress the tens of billions of dollars needed for repairs to the nation's aging dam infrastructure.

Largely as a result of the funding shortfall, in its latest infrastructure report card, in 2017, the American Society of Civil Engineers (ASCE) gave the nation's 91,000-plus dams **a D grade**, the same grade they have received in every ASCE report card since the first one was issued in 1998. The ASCE estimated the cost of rehabilitating dams whose failure would threaten human life at nearly $45 billion, and the cost of fixing all dams in need of repair at more than $64 billion. This year, the Association of State Dam Safety Officials (ASDSO) arrived at an even higher number — **nearly $71 billion for all dams.**

"There's a huge backlog of rehabilitation needs regarding dams in our country," said Lori Spragens, ASDSO's executive director. "Regular citizens are unaware that the dams around them may be risks, and there's not enough public awareness for people to be prepared, just like they would be for a tornado or an earthquake."

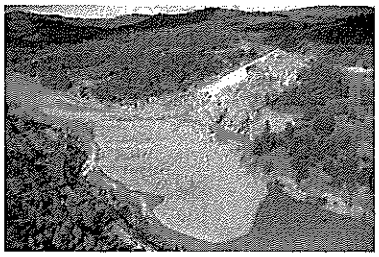
And scientists say the likelihood of dam failures — which not only threaten lives but also release toxic sediments trapped in reservoirs behind many dams — will increase as extreme precipitation events become more frequent in a warming world.

Aside from about 1,500 dams owned by federal agencies, regulating dam safety is chiefly a state responsibility, and states vary widely in their commitment to the task. Across the nation, each state dam inspector is responsible on average for about 200 dams, a daunting ratio, but in some states the number is much higher. Oklahoma, for example, employs just three full-time inspectors for its 4,621 dams; Iowa has three inspectors for its 3,911 dams. Largely because of its legislators' distrust of regulation, Alabama **doesn't even have a safety program** for its 2,273 dams.

States require inspections of "high-hazard-potential" dams, whose failures would cause fatalities, every two-and-a-half years on average, but actual inspection intervals are much longer. Eleven states don't inspect "low-hazard-potential" dams — dams that don't threaten lives or property — at all.

Among states given high marks for their programs are Pennsylvania, New Jersey, Colorado, Washington, New Mexico, and, at the top of most lists, California, which spends the most of any state on dam safety, **more than $21 million** in 2017. Yet an **independent report** on the causes of the Oroville incident published in January 2018 faulted California's dam safety practices in numerous ways.

While the dam was inspected regularly, safety officials failed to look more deeply into the dam's history, and consequently missed deficiencies in its main spillway that stemmed from its design and construction. California's Department of Water Resources was



An aerial view of the damaged Oroville Dam spillway in California, and the debris field just below, in February 2017. Photo by California Department of Water Resources

"overconfident and complacent about the integrity" of its dams, and was "chronically" understaffed, the report said. And the department lacked expertise in dams' secondary structures, such as the failing spillways.

"The fact that this incident happened to the owner of the tallest dam in the United States, under regulation of a federal agency, with repeated evaluation by reputable outside consultants, in a state with a leading dam safety regulatory program, is a wake-up call for everyone involved in dam safety," the report said. "Challenging current assumptions on what constitutes 'best practice' in our industry is overdue."

Until the 1970s, information about the nation's dams was scant: some hadn't been inspected for decades, and nobody knew how many existed. After numerous dam disasters, the nation's **first dam inventory** in the early 1970s established the existence of nearly 90,000 non-federal dams, most of them small. Inspections of about 9,000 of them found that a third were unsafe. Since the federal government had no responsibility for those dams, the states then began to take their dam safety responsibilities seriously.

Dam safety programs are generally considered to have improved since then, but dam failures — the rapid, uncontrolled release of water when dams are breached or collapse — are still frequent. According to the ASDSO, between January 2005 and June 2013, state dam safety programs reported 173 dam failures and 587 "incidents" — events that probably would have resulted in failures if not for quick interventions.

Fatalities caused by dam failures are far less common. Since the collapse of the Kaloko Dam in Hawaii in 2006, which killed seven people, no deaths occurred until this March, when Nebraska's Spencer Dam, just 29 feet high, gave way to epic floodwater, sweeping away a house with a man inside it in the floodplain below.

One sure way to eliminate a dam's danger is to dismantle it, but the impact on safety of the budding U.S. dam removal movement has been minimal. One reason is that most of the removed dams were small, less than 25 feet high; another is that relatively few dams have been removed. Last year marked a high point, with **99 dams taken down**. But that number represents only about a thousandth of the nation's dam stock.

Conservation groups and anglers' organizations such as Trout Unlimited have led the drive to take down U.S. dams, often to help restore long-blocked fish migrations. These groups note that removing a small dam may cost less than repairing it. But removing a large dam can cost as much as building it in the first place. Efforts to dismantle large dams on major rivers, such as the Snake River in the Pacific Northwest, have faced strong resistance from business groups and utilities, which defend the dams for generating hydropower and creating reservoirs used to ship grain and other commodities.

READ MORE: After a long boom, an uncertain future for big dam projects.

As sobering as the problem of dam safety is in the United States, consider that aside from Australia, Canada, and Western Europe, dam safety standards in the rest of the world lag behind the U.S. Catastrophic failures are frequent: Since August 2008, when a dam in Nepal gave way, killing 250 people, at least 10 dam failures have each killed 10 or more people. In January, a mining dam in southeastern Brazil collapsed, killing about 300 people. Last year, a dam under construction in Laos crumbled, killing 40 people and leaving 6,600 homeless, and a dam in Kenya burst, killing 48 people.

Members of a rescue team search for victims after a tailings dam owned by Brazilian mining company Vale SA collapsed, in Brumadinho, Brazil January 28, 2019. Photo by REUTERS/Adriano Machado

In the U.S., three interlocking developments have impeded improvements in dam safety in recent decades. First, the nation's dams are growing old: **their average age is 57.** By that age, seepage can start to erode dams' foundations — the U.S. Army Corps of Engineers spends about $200 million a year to address seepage on its dams alone. And parts such as spillway gate, motors, winches, and generators wear out and need replacement.

Second, dams are vulnerable to so-called "hazard creep": their danger increases as development occurs downstream. A dam that was rated "low-hazard-potential" when it was built because nobody lived in the floodplain below may become a "high-hazard-potential" dam once people move into the area. As a result, even though new dam construction in the U.S. virtually stopped in

the 1970s, the number of high-hazard-potential dams has grown from 9,314 in 1999 to 12,557 in 2017.

High-hazard-potential dams must conform to a more rigorous safety standard than lesser-rated dams, but if funds aren't available, the necessary upgrades won't be made. And dam safety officials are often slow to reclassify dams. Neither Kaloko nor Spencer dams, for example, were rated high-hazard before their fatal collapses.

Hazard classifications have other problems, too. Owners of high-hazard-potential dams are supposed to maintain emergency action plans to notify downstream residents of imminent danger from a dam, but according to Mark Ogden, an ASDSO outreach specialist, nearly 20 percent of high-hazard-potential dams lack such plans.

And while hazard classifications take into account threats to human life, they don't consider the environmental and economic damage that could be caused by the release of toxic sediments. That sediment may include agricultural pesticides, mining tailings, and industrial chemicals.

Despite the potential dangers posed by dams, many people living on property that would be flooded if a dam fails are unaware of that possibility, in part because federal officials blocked public access to inundation maps after the September 11, 2001 terrorist attacks. In recent years, some states have again made the maps available. California requires that prospective buyers be informed if a property is in an inundation zone, a practice that should be far more widespread.

The third development affecting dam safety is a deepening understanding of hydrological conditions and earthquakes, both of which are vital considerations in dam design. Assumptions about floods and precipitation when dams were built were typically based on a short history of hydrological data, and another half-century or more of information often has pointed to different conclusions. Climate change, which is intensifying both floods and drought, has further undermined those assumptions.

The result is that the methods dam designers and safety officials have customarily used are increasingly considered inadequate. Dam design traditionally has been based on calculations of its watershed's "probable maximum flood," or PMF, the largest flood that could conceivably occur there. High-hazard-potential dams were supposed to be able to safely handle PMFs; low-hazard dams usually were required to contain some fraction of their PMFs. And if accumulating hydrological data showed that a dam's original PMF was too low, the dam could be labeled out of compliance and required to undergo repairs, often by enlarging its spillway. Indeed, about half the investment in dam repairs throughout the U.S. involves modifying spillways to accommodate larger floods, according to Eric Halpin, who retired in January after 14 years as chief of dam and levee safety at the Army Corps of Engineers.

A girl uses a mattress as a raft during the flood after the Xepian-Xe Nam Noy hydropower dam collapsed in Attapeu province, Laos July 26, 2018. Photo by REUTERS/Soe Zeya Tun

But focusing solely on PMFs entirely omits the varying levels of risks that dams may pose. One PMF may be calculated to have a one-in-a-thousand chance of occurring in a given year, while another might be pegged at one-in-a-million. And a few people might live in the floodplain below one dam, while a million might live downstream from another. As a result, the Bureau of Reclamation abandoned its focus on PMFs in favor of risk-based assessments about 25 years ago, and the Army Corps of Engineers followed a decade later. Now risk assessment is making its way into the procedures of some state dam safety agencies.

Incorporation of climate change into dam safety practices is still limited by scientists' inability so far to quantify the frequency and intensity of future flooding in particular localities. One small step in that direction has been taken at California's Folsom Dam, which recently became the first dam to use National Weather Service forecasts about future precipitation to help guide decisions about whether to release water from the dam's reservoir. Until now, release decisions were based entirely on readings of precipitation that had already occurred.

Even with smart measures like these, major advances in dam safety almost certainly won't occur until legislatures begin appropriating many billions of dollars more for repairs. Instead, since a majority of dams are privately owned, about half the states have shifted to owner-responsible inspection systems, in which dam owners are required to hire inspectors and pay for the inspections themselves instead of relying on state inspectors.

READ MORE: Crisis on the Colorado: The West's great river hits its limits.

"In my last 15 years in government," Halpin said, the Army Corps of Engineers "invested half-a-billion to a billion dollars a year in infrastructure repairs. During that same period, Congress appropriated $200 billion for emergency funds to repair infrastructure damage from storms" such as Katrina and Sandy. "Everyone knows it's more cost-effective to prevent damage than to repair it, but it's not in the national will yet. This is not politically sexy."

This article was originally published by ***Yale Environment 360****. Read the original story here.*

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